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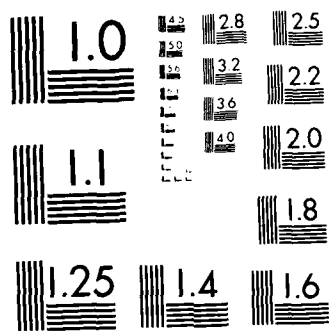
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A 10x10 grid of squares is shown. The top-left square is shaded black. A vertical ruler is placed along the right edge of the grid, showing a scale from 0 to 10 cm. The ruler is marked in centimeters, with millimeter increments. The grid is used to illustrate the concept of area and measurement.



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

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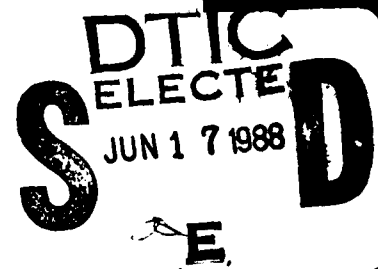
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AD-A195 953

Bibliography of In-House and Contract Reports, Supplement 15

Annemarie Black
E. James Books
Karen Carroll

April 1988



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U.S. ARMY CORPS OF ENGINEERS
ENGINEER TOPOGRAPHIC LABORATORIES
FORT BELVOIR, VIRGINIA 22060-5546



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PREFACE

This is Supplement 15 to the report titled, "Bibliography of In-House and Contract Reports" AD-877 653L; Supplement 1, AD-890 066L; Supplement 2, AD-905 548L; Supplement 3, AD-B005 275L; Supplement 4, AD-B010 642L; Supplement 5, AD-B019 966L; Supplement 6, AD-055 468; Supplement 7, AD-A068 744; Supplement 8, AD-A084 111; Supplement 9, AD-A099 803; Supplement 10, AD-A113 006; Supplement 11, AD-A128 400; Supplement 12, AD-A141 778; Supplement 13, AD-A160 607; and Supplement 14, AD-A173 750. It is a continuing bibliography of reports prepared by and for the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia. This bibliography includes reports that were published from 1 January 1986 through 31 December 1987.

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COL Alan L. Laubscher, EN, was Commander and Director, and Mr. Walter E. Boge was Technical Director of the Engineer Topographic Laboratories during the report preparation.


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**ADVANCED DEVELOPMENT PROTOTYPE (ADP) FOR THE
QUICK RESPONSE MULTICOLOR PRINTER (QRMP)**

May 1987

Green, Dale L. Froelich, Ronald W. Lehmann, Ernest H.
Griffin, Gordon R. Strobele, Caljon H.
Nothmann, Gerhard A. Davidson, James R.

Xerox Corporation

DAAK70-80-C-0112

Keywords: Map Printer, Color Xerography, Quick-Response Color Reproduction, Color Laser Printer, Color Image Processing, Laser Scanning Xerography, Laser Reprography, Color Reproduction

The report discusses the design, fabrication and testing of an Advanced Development Prototype (ADP) for the Quick Response Multicolor Printer (QRMP). The ADP is a color electronic reproduction system which produces high quality 24- by 30-inch copies of maps, terrain analysis printouts, photographs, and similar products. For the field Army, the QRMP will be able to quickly provide full color copies of these products on high wet strength paper. The ADP can reproduce a color map sheet in 1 minute or produce 75 full color copies per hour.

ETL-0400

AD-A168 347

**TECHNIQUES TO IMPROVE ASTRONOMIC POSITIONING
IN THE FIELD**

December 1985

Baldini, Angel A.

Keywords: Astronomic Positioning Observations and Computations, Effects of Instrumental Errors

This paper deals with new methods and techniques for improving astronomic positioning in the field. Latitude and longitude are obtained by observing transit times of pairs of stars over a fixed vertical plane, independent of azimuth and zenith distances. A unique solution is derived for each pair. Higher accuracy in latitude can be obtained by observing transit times of star pairs over the prime vertical, where the parallactic angle reaches its maximum value. The vertical plane of observation can be fixed within 90 arc seconds with respect to the prime vertical without changes in the star's parallactic angle, and a function of it, the latitude, can then be computed. The star transit times over different vertical lines are thereby reduced to the central line of collimation plane, as a function of the parallactic angle. Higher accuracy in longitude can be achieved by observing the transit times of pairs of stars over a vertical plane fixed within 20 arc minutes with respect to the meridian plane. Each individual star pair will determine a solution. Since each pair does not depend on azimuth orientation, the star pairs can be chosen arbitrarily with respect to declination or zenith distance, and short periods of clear sky observations can be utilized. When several pairs are observed an adjustment can be carried out through the equations of conditions that allow one to detect errors in either the transit times or in the star's right ascensions.

ETL-0401

AD-B101 097L

**SYNTHESIS GUIDE FOR HELICOPTER LANDING ZONE
AND DROP ZONE SITES
December 1985**

Falls, Robert A.

Keywords: Helicopter Landing Zone, Drop Zone, Topographic Map, Factor Overlay, Synthesis, Terrain Analysis

This report provides a step-by-step instruction for synthesizing helicopter landing zones and drop zones from previously prepared terrain factor overlays. The synthesis procedure is essentially manual and relies on precalculated tables and nomographs to produce a map-like terrain product for fully loaded aircraft.

ETL-0413

AD-B101 706L

**AUTONOMOUS LAND VEHICLE
July 1986**

Lowrie, J.	Greunke, R.
Gremban, K.	Thomas, M.
Gothard, B.	Koenig, R.
Celvi, G.	Rehn, R.

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Robotics, Image Understanding, Unmanned Vehicles, Automation, Artificial Intelligence

The Autonomous Land Vehicle (ALV) project is sponsored by the Defense Advanced Research Projects Agency as part of its Strategic Computing (SC) Program. Its purpose is to advance the state of the art in artificial intelligence, image understanding, and advanced computer architectures and to demonstrate the applicability of these technologies to advanced military systems. The Strategic Computing Program is separated into three primary areas--technology base, applications, and infrastructure. The ALV project is one of the SC program's application areas aimed at advancing and demonstrating the state of the art in autonomous navigation.

**ASTROGEODETTIC-INERTIAL METHODS FOR VERTICAL
DEFLECTION DETERMINATION
December 1985**

Bose, Sam C.

Applied Science Analytics, Inc.

DACA72-84-C-0017

Keywords: Inertial Surveying, Deflections of the Vertical, Astrogeodetic Observations, Azimuth Observation, Inertial Error Models, Kalman Filter Updating, Statistical Collocation, Least Squares Estimation

Considerable progress has been made in inertial surveying by the Position and Azimuth Determining System (PADS) developed by Litton Systems, Inc., for the U.S. Army Engineer Topographic Laboratories (ETL). Following the installation of an improved vertical accelerometer and other modifications, the PADS has been renamed Inertial Positioning System (IPS). The IPS, with some software changes as to gyro error control, has served as the Rapid Gravity Survey System (RGSS) for ETL. The present RGSS operates as a quasi-local level system and permits Kalman stochastic error control using observed velocity errors at vehicle stops. A new optimal data reduction method for estimating the deflections of the vertical is presented. The method requires RGSS horizontal velocity errors at each stop and the inertial system real-time Kalman filter update gains. Storage of real-time covariance data is not necessary. Survey *traverse initial and terminal astrogeodetic deflections* are utilized along with terminal platform azimuth error observation to estimate approximate gyro biases. The error models used preserve the inertial system dual horizontal interaction and exploit statistical collocation techniques to preserve correlations between the two components of the deflection of the vertical which are least squares estimated using all data simultaneously.

ETL-0415

AD-B098 897L

**AN EXPERT SYSTEM FOR THE COMPUTER-ASSISTED IDENTIFICATION
OF FEATURES ON SAR IMAGERY**
January 1986

Pascucci, Richard F.

Autometric, Incorporated

Keywords: Expert System, SAR Imagery, Knowledge Base, Descriptor Sets, Computer Vision, Condition/Action Rules

This investigation tested and validated descriptor sets that had been compiled in an earlier investigation. The research project then went on to develop the basis for an expert system that consists of (1) a knowledge base containing expert radar image analysts' units of knowledge in the form of feature descriptors along with condition/action rules for combining the descriptors into sets that are formulated as complex Boolean expressions containing the logical operators AND, OR, and NOT; and (2) an automated inference engine that decomposes the complex Boolean expressions into simple AND statements and applies if-then rules to the knowledge base, thereby inferring the identification of features from the AND-statement descriptor sets. In the system's present form, SAR imagery is examined by image analysts who record feature descriptors and enter them into the knowledge base. The goal of ensuing phases of the investigation will be to develop computer vision techniques that will recognize these descriptors and enable the system to perform automated feature recognition.

ETL-0416

AD-A170 138

WORLD WEATHER EXTREMES
December 1985

Riordan, Pauline
Bourget, Paul G.

Keywords: Extremes, Weather, Weather Observations, Meteorological Charts, Temperature, Precipitation (Meteorology), Atmospheric Pressure, Solar Radiation, Wind (Meteorology), Weather Intelligence, Humidity, Fog, Thunderstorms

This report consists of a worldwide map of weather extremes and a separate map for the United States and Canada, with comments on the reliability of the records shown. Included are highest and lowest temperatures, largest temperature variations, greatest and least amounts of precipitation for various durations, maximum precipitation variabilities, greatest thunderstorm frequencies, highest and lowest atmospheric pressures, highest solar radiation, largest and heaviest hailstones, greatest snowfalls, highest wind speeds, high dew point, and most frequent occurrences of fog. Where appropriate, the value for the highest and lowest annual mean is also given. As far as possible, the records are taken from official sources, and all of them are documented. Conditions of site, instrumentation, observational procedure, and other factors such as environmental and meteorological conditions pertinent to the reliability of extremes are discussed.

ETL-0417

AD-A168 337

**RESEARCH IN EXPERT INTERACTIVE
CARTOGRAPHIC SYSTEMS**

May 1986

Hanson, Andrew J.

SRI International

DACA72-85-C-0008

Keywords: Spatial Reasoning, Cultural Object Detection, Image Segmentation

We have carried out a research program in the application of interactive environments to the development of knowledge-based methods for image understanding. As a sample domain, we chose to work mainly on the problem of locating generic cultural objects in aerial imagery. The discovery of such objects was accomplished by defining a generic model for rectilinear objects, along with rules for parsing the image geometry and correcting probable errors of the segmentation algorithm. These tools permit the semantic resegmentation of an initial syntactic scene partition to yield well-delineated buildings. The method owes its success to the combined utilization of both high-level and low-level knowledge about the target object context and the image.

ETL-0418

AD-A168 376

**CUMULATIVE PROBABILITY TABLES FOR TESTING
CONSENSUS IN RANKING EXPERIMENTS**

May 1986

Crombie, Michael A.

Webb, Jennifer

Keywords: J-Statistic, Monte Carlo, Ranking Experiments, Consensus

Probability tables are provided that will enable analysts to test for consensus among N judges when comparisons are made R at a time of M items. The purpose of the tables is to provide a statistical basis for determining whether rank ordering of alternatives can best be determined by reviewing the M options all at once or ranking $R < M$ at a time.

ETL-0419

AD-A172 315

**CONVERSION OF THE CALAP PROGRAM
FROM FORTRAN TO DUCK
Final Report
September 1986**

Corporate Authorship

Smart Systems Technology, Incorporated

DAAK70-82-C-0027

Keywords: CALAP, DUCK, Artificial Intelligence, Logic Programming

An expert advisor program named CALAP (Computer Aided Landform Analysis Program) was developed by Dr. Robert Leighty, working at the U.S. Army Engineer Topographic Laboratories. The original program was developed in FORTRAN on an HP-1000, a minicomputer. CALAP was reprogrammed in an Artificial Intelligence (AI) language called DUCK. DUCK is a Logic Programming Language developed at Yale by Prof. Drew McDermott. CALAP has previously been translated into another AI language called OPS5. The experience of translating CALAP to DUCK is documented here.

ETL-0420

AD-A171 575

**DEFENSE MAPPING AGENCY ADVANCED RASTER-TO-VECTOR
BENCHMARK TESTING
June 1986**

Selden, David D.

Battelle Memorial Institute

DAAG29-81-D-0100-1801

Keywords: Raster-to-Vector, Cartographic Data Capture, Benchmark Testing, Scanning, Editing, Error Detection/Correction

Battelle Columbus Division in cooperation with the U.S. Defense Mapping Agency and U.S. Army Engineer Topographic Labs has developed a methodology for testing and evaluation of automated cartographic editing functions provided by cartographic data capture systems. Editing functions include gap closure, spike removal, "snow" removal, node snapping, centerline adjustment, etc. These functions are often implemented in three modes: automatic, computer-assisted, and manual. The Battelle benchmark testing method focuses on automated editing. The testing and evaluation method consists of a single analog (film positive) edit test sheet and a series of test procedures. The edit test sheet portrays a column of cartographic patterns with anomalous versions of these cartographic geometries arrayed in rows to their right. Different lineweights and pattern orientations are also utilized. The full range of editing functions are applied to the data to test for rates of success and sensitivity to geometry, lineweight, and orientation.

ETL-0421

AD-B103 847L

SIMPLIFIED ELECTROSTATIC COLOR PRINTING
June 1986

Chou, Hsin-hsin
Kidnie, Kevin M.
Mikelsons, Valdis

3M

DACA72-85-C-0016

Keywords: Mapping, Digital Systems, Electrostatic Printing, Plotters, Cartography, Graphics

The potential of the "direct" and "transfer" imaging methods for high quality multicolor electrostatic printing has been evaluated on the basis of experimental work done in this laboratory and on information available in open literature.

The liquid development process and the subsequent image drying step appear to be the limiting factors for the rate at which full-color images can be generated. Sharp, brightly colored images with good color transparency have been produced on a thermoplastic receptor surface. The "transfer" process was selected as the imaging method of choice because of easier color registration and, possibly, lower sensitivity to ambient relative humidity effects.

**IBIS QUERY -- SOFTWARE TO SUPPORT THE IMAGE BASED
INFORMATION SYSTEM (IBIS) EXPANSION
FOR MAPPING, CHARTING, AND GEODESY**

June 1986

Friedman, Steven Z.
Walker, Richard E.
Aitken, Robert B.

Jet Propulsion Laboratory

Keywords: Geographic Query, Spatial Data, Polygon Overlay

The Image Based Information System (IBIS) has been under development at the Jet Propulsion Laboratory (JPL) since 1975. It is a collection of more than 90 programs that enable processing of image, graphical, and tabular data for spatial analysis. IBIS can be utilized to create comprehensive geographic data bases. From these data, an analyst can study various attributes describing characteristics of a given study area. Even complex combinations of disparate data types can be synthesized to obtain a new perspective on spatial phenomena.

In 1984, new query software was developed enabling direct Boolean queries of IBIS data bases through the submission of easily understood expressions. An improved syntax methodology, a data dictionary, and display software simplified the analysts' tasks associated with building, executing, and subsequently displaying the results of a query. The primary purpose of this report is to describe the features and capabilities of the new query software. A secondary purpose of this report is to compare this new query software to the query software developed previously (Friedman, 1982). With respect to this topic, the relative merits and drawbacks of both approaches are covered.

ELECTRONIC PRINTING SYSTEMS

July 1986

Gladden, James W.

Keywords: Battelle's GSC Process, Digital Maps, Electronic Printing Systems, Ink Jet Printing, Ionographic Printing, Laser Color Photography, Laser Xerography, Magnetic Printing, Non-Impact Printing, Thermal Transfer Printing

A technical review is given of different electronic printing systems that analyzes the systems for suitability in Quick Response Multicolor Printing. The systems treated include ink jet printing, ionographic printing, laser color photography, laser xerography, magnetic printing, and thermal transfer printing. The respective electronic printing systems are compared and contrasted.

ETL-0424

AD-A173 601

SPARSE AREA STEREO MATCHING EXPERIMENT
July 1986

Crombie, Michael A.

Keywords: X-Parallax, Optimum Resolution, Y-Parallax, Cooperative Processing, Digital Imagery, Semiautomatic Processing

The algorithm used in this experiment is considered by many to be state-of-the-art for calculating x-parallax over rural regions. Even so, its output must be refined in sparse areas in order to meet accuracy requirements. The major result of this experiment showed that x-parallax should be measured from digital imagery containing no more than 10 line pairs per millimeter.

ETL-0425

AD-A170 884

**INTEGRATION OF ARTIFICIAL INTELLIGENCE CONCEPTS
INTO THE METHODS FOR EXTRACTING LINE OBJECTS
FROM MONOCHROMATIC AERIAL IMAGERY**
March 1986

Kazmierczak, H.

European Research Office

DAJA45-84-C-0014

Keywords: Automatic Image Processing, Object Extraction, Artificial Intelligence Aspects, Digital Elevation Data

Procedures for automatic extraction of line shaped objects from aerial images have been improved and completed. A general model of road network has been used to complete road extraction from images. Digital elevation data has been used to guide the process of river and creek extraction from images. The methods have been implemented on a DEC VAX 11/780. The functions are described in detail. Test results and assessment are included in the report.

ETL-0426

**AUTOMATIC CORRELATION OF USGS DIGITAL LINE GRAPH
GEOGRAPHIC FEATURES TO GNIS NAMES DATA
August 1986**

Heard, Andrew M.

Battelle Memorial Institute

DAAG29-81-D-0100

Keywords: Artificial Intelligence, Automated Cartography, Automated Map Generation

An accelerating interest in automatic name placement has revealed a growing need for the creation of cartographic data bases. An effort has been made to create such a data base from two extant types of digitized United States Geologic Survey map data. Features are defined by geographic data stored as graphic elements in the USGS 1:2,000,000 Digital Line Graph data files. These features are then used as a set onto which names extracted from the Geographic Names Information System data files are mapped. This mapping serves as a cartographic data base, supplying both a label and a graphic description of specific geographic features. Automatic generation of this data base draws nearer the realization of automated map generation.

ETL-0427

**A STATE-OF-THE-ART ASSESSMENT
OF AUTOMATIC NAME PLACEMENT
August 1986**

Freeman, Herbert

Battelle Memorial Institute

DAAG29-81-0100

Keywords: Artificial Intelligence, Automated Cartography, Automated Map Generation

This report reviews the state of the art of map name placement. A literature survey is provided of all the recent publications dealing with this topic. Some good-quality experimental systems are currently available; however, considerable further development is required before a fully automatic name placement system will be available that approaches the aesthetic quality obtainable from experienced manual placement.

**KNOWLEDGE-BASED VISION TECHNIQUES--
TASK B: TERRAIN AND OBJECT MODELING RECOGNITION
August 1986**

Lawton, Daryl T.
Levitt, Tod S.
Glicksman, Jay
McConnell, Christopher C.

Miltonberger, Thomas E.
Muller, Hans E.
Nelson, Philip C.
Neveu, Charles F.

Advanced Decision Systems

DACA76-85-C-0005

Keywords: Model-Based Vision System, Terrain Modeling, Schema-Based Reasoning, Perceptual Processing, Image Understanding Tools, Spatial Representation, Hypothesis Management, Navigation, Image-To-Map Matching

This report describes research in perceptual processing and object modeling for several tasks necessary for the functioning of an Autonomous Land Vehicle. These include terrain classification, object recognition, automatic landmark extraction and recognition, and representing *a priori* and derived information about the environment in a spatial map that can be updated and also represent the uncertainty of perceptual inferences.

Key results include:

- Design of a vision system architecture and the implementation of a supporting environment and system components for experimentation. These include data bases and a uniform query mechanism for extracted perceptual structures, grid-based and object-based terrain models, and rules for perceptual processing and instantiating object models.

- Development of schemas and schema networks for modeling and recognizing objects and terrain.

- Development of recognition processes using perceptually-based grouping processes controlled by heuristic measures of interestingness. This allows for recognition to be an active process and for instantiating qualitative predictions made from instantiating object models.

- Development of a two-dimensional edge operator and ribbon-extraction algorithms.

- Demonstration of terrain, tree and road modeling, prediction, and recognition.

- Design and implementation of the Perceptual Structures Data Base (PSDB), automatic query compilation for PSDB access, and novel grouping processes to operate on PSDB information.

- Design of a calculus for spatial reasoning.

- Implementation of transformations and data base technology for long term grid, overlay, and landmark data.

- Demonstration of landmark recognition and model-based road-following from the Martin Marietta test site.

ETL-0429

AD-A170 979

INVERSE PERSPECTIVE OF A ROAD FROM A SINGLE IMAGE
August 1986

DeMenthon, Daniel

University of Maryland

DACA76-84-C-0004

Keywords: Computer Vision, Autonomous Navigation, Road Following

A method is presented for reconstructing the geometry of a road from a single image of the road. The road is modeled as a space ribbon defined by a spine (centerline) and generators which are horizontal line segments cutting the spine at their midpoint at a normal angle. Properties of two neighboring generators of such a ribbon are examined, and it is found that if a generator is known, a neighbor is completely defined if one of its ends is known. The proposed method uses this property to reconstruct the visible part of the world road, by iteratively finding a series of generators. The proposed method is tested against a simple method which assumes that the ground is flat and against another method which uses vanishing points.

ETL-0430

AD-B104 556L

THE AUTONOMOUS LAND VEHICLE 1ST QUARTERLY REPORT
May 1986

Lowrie, James

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Autonomous Navigation, Computer Vision, Road Following

The report covers problems and progress on the Autonomous Land Vehicle (ALV) Project at Martin Marietta during the first quarter of 1986, approximately January to April, and summarizes plans for the second quarter of 1986. This report provides a description of the basic road-following software system as developed for the November 1985 and May 1986 demonstrations, specifically the reasoning and vision software. The physical vehicle and its electronics have remained largely unchanged from the configuration outlined in the 1985 ALV Annual Report. The focus of this quarterly report is road-following software. In addition, research on advanced architectures to support 1987 and beyond demonstration requirements is included.

ETL-0431

AD-B105 997L

KNOWLEDGE-BASED VISION TECHNIQUES
August 1986

Tseng, D. Y. Vilmrotter, F. M.
Daily, M. J. Reiser, K.
Olin, K. E.

Hughes Aircraft Company

DACA76-84-C-0007

Keywords: Computer Vision, Obstacle Detection, Obstacle Avoidance, Virtual Sensors, Knowledge Representation

The Hughes system is designed to achieve the perceptual requirements of the Autonomous Land Vehicle (ALV) for navigation in an unconstrained outdoor environment. The system reflects the new approaches needed to perform image understanding in support of an ALV planning and navigation system. The Hughes Obstacle Avoidance system is a multilevel knowledge-based perception system capable of extracting features from sensed images as well as reasoning about perceived objects. Each layer of the system reflects a different level of data assimilation versus data immediacy. Reasoning about expected world objects is performed by both the perception and planning systems, and provides the most consistent world model at each level. The system supports temporal understanding and sensor fusion as required for obstacle avoidance maneuvers.

This report documents the first year of effort for the Knowledge-Based Vision Techniques contract. It includes a discussion of the conceptual design of the multilevel perception system, the feature extraction algorithms developed for obstacle detection with laser range and color imagery, and the merging of multisensor information into a local map to be used for avoidance planning and maneuvering.

ETL-0432

AD-A171 618

VISION-BASED NAVIGATION FOR AUTONOMOUS GROUND VEHICLES
1986 ANNUAL REPORT
August 1986

Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Autonomous Navigation, Road Following, Computer Vision

This is an annual report for the project "Vision-based navigation for autonomous ground vehicles" being conducted under Contract DACA76-84-C-0004 (DARPA Order 5096) for the period 1 July 1985 through 30 June 1986. The project to date has focused on three tasks: (1) support of Martin Marietta as the Autonomous Land Vehicle (ALV) integrating contractor, (2) development of a vision system for autonomous navigation of roads and road networks, and (3) experiments using this vision system on the ALV. Progress on each of these topics is described in this report.

ETL-0433

AD-A171 561

A PROGRAMMING ENVIRONMENT FOR PARALLEL VISION ALGORITHMS
August 1986

Brown, Christopher

University of Rochester

DACA76-85-C-0001

Keywords: Parallel Processors, Butterfly Computer, Computer Vision

During the first year of the award period, the Computer Science Department of the University of Rochester has pursued three main lines of work: systems support algorithms, butterfly programming environment, and vision applications. Today's multiprocessor computer architectures are not efficiently programmed or even conceptualized with standard computer languages, and their operating systems and debugging tools are also challengingly different. The University of Rochester is doing work in the area of tools for controlling large-grain parallelism, as one finds in a distributed multiprocessor application like the Autonomous Land Vehicle, or in tightly coupled processors like the Hypercube or the Butterfly Parallel Processor.

ETL-0434

AD-A173 750

BIBLIOGRAPHY OF IN-HOUSE AND CONTRACT REPORTS,
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Books, E. James
Fox, Margaret F.
Holmes, Alice L.

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ETL-0435

AD-A173 883

AN EDGE DETECTION EXPERIMENT USING THE MARR OPERATOR
August 1986

Crombie, Michael A.
Bosch, Edward H.

Keywords: Edge Detection, Marr Operator, Binary Image-Processing

An edge detection experiment using the MARR operator was conducted at ETL to determine if the operator could be used in an interactive manner to extract well-defined edges from noisy pictures. Three binary image-processing functions, namely, line thinning, line thickening and clutter removal were found to be useful aids in the interactive process. The results of the experiment demonstrate that the MARR operator was not biased and performed as well as the Prewitt and Haralick operators, all of which is contrary to an experiment conducted by Haralick where the operator was used incorrectly.

ETL-0436

AD-B106 844L

THE AUTONOMOUS LAND VEHICLE 2ND QUARTERLY REPORT
September 1986

Lowrie, James

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Autonomous Navigation, Computer Vision, Road Following

The report covers problems and progress on the Autonomous Land Vehicle (ALV) Project at Martin Marietta during the second quarter of 1986, approximately April to July, and summarizes plans for the third quarter of 1986. A description of the new parallel processing computer hardware architecture designed for phased implementation on both the vehicle and in the research lab, in preparation for the 1987 ALV demonstration and technology status review, is provided. Performance of the video data processing portion of the perception subsystem has been improved through the implementation of a processing technique labeled "power windows," which is detailed. A correlator is described which has been designed to aid the navigator. In addition, data collection by the Environmental Research Institute of Michigan (ERIM) at Martin Marietta in support of the ALV project is continuing.

**DYNAMIC IMAGE INTERPRETATION
FOR AUTONOMOUS VEHICLE NAVIGATION
September 1986**

Riseman, Edward M.
Hanson, Allen R.

University of Massachusetts

DACA76-85-C-0008

Keywords: Scene Interpretation, Sensor Motion, Spatial Reasoning

The University of Massachusetts Autonomous Land Vehicle Project has been concerned with a variety of problems associated with sensor motion analysis and dynamic image interpretation for autonomous navigation.

In particular, our research has the following long-range research goals that relate to Task D in the autonomous vehicle navigation program:

1. Determine the motion parameters of a sensor relative to the static environment.
2. Distinguish moving objects from the static environment and determine their motion parameters.
3. Develop algorithms for tracking and predicting the motion and environmental location of the sensor and moving objects.
4. Build a reliable depth map of the environment from combined motion, stereo, and laser range data.
5. Identify major objects (both static and moving) in the environment while the sensor is either stationary or in motion.
6. Interpretation of the environment (i.e. object identification in road scenes) to provide constraints for identifying and tracking moving objects.
7. Provide information to update an environmental model of the moving sensor, including location of the sensor, other moving objects and distinguished stationary objects.
8. Provide control information to an expert navigational and spatial-reasoning system for the purposes of path planning and obstacle avoidance.
9. Integrate all of the above capabilities into a flexible and extensible system for dynamic scene interpretation.

ETL-0438

AD-A175 103

THE HOUGH TRANSFORM ON THE BUTTERFLY AND THE NCUBE
September 1986

Chandran, Sharat
Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Parallel Implementation, Butterfly Parallel Processor, NCUBE, Hough Transform

This report describes the parallel implementation of the Hough Transform, a technique to detect colinear edge points. Specifically, two contrasting architectures, the Butterfly Parallel Processor, essentially a shared memory machine, and the NCUBE, a direct connection machine in which processors are interconnected in the form of a hypercube, are considered.

Developing parallel Hough transform algorithms involves addressing questions of optimal processor allocation and parallel "peak" selection in image neighborhoods. Fast, practical algorithms (subject to inherent lower bounds) are presented, and relevant complexity issues are discussed.

ETL-0439

AD-B107 697L

**KNOWLEDGE-BASED VISION TECHNIQUES FOR THE
AUTONOMOUS LAND VEHICLE PROGRAM**
September 1986

Fischler, Martin A.
Bolles, Robert C.

SRI International

DACA76-85-C-0004

Keywords: Knowledge Representation, Computer Vision, Mission Planning, 3D Descriptions

The goal of this research is to develop techniques for representing knowledge about complex cultural and natural environments so that a computer vision system can successfully recognize key navigational features, such as roads, bushes, cliffs, and buildings. Our research strategy is to (1) develop representations and techniques for storing (or incrementally learning) semantic and geographic information about a specific geographic area to permit both mission planning and knowledge-based interpretation of sensed data, (2) develop representations for natural and man-made objects, (3) develop techniques to predict distinctive features of these objects that can be used to identify them, and (4) develop techniques for building three-dimensional descriptions of an environment from data gathered by range or intensity sensors moving through this environment. In this report we describe our progress and plans in these areas.

DETERMINING AN AZIMUTH WITH A GYROTHEODOLITE
October 1986

Logan, Kevin P.

Keywords: Gyrotheodolite, WILD GAK1, Azimuth Determination, Survey Procedures

This report is intended as a practical guide to surveyors for making measurements to determine an azimuth using a gyrotheodolite. This report gives a brief description of how the gyro works, improved observing procedures for its use, and the results of field observation. Accuracies of ± 5 arc seconds can be obtained.

SIMPLE ANALYTICAL METHODS FOR ESTIMATING
SHORT-TERM RAINFALL
November 1986

Wexler, Ruth L.

Keywords: Climatic Index, Daily Rainfall, Hourly Rainfall, Instantaneous Rainfall, Rainfall Distributions, Rainfall Models, Short-Term Rainfall

Information on short-term rainfall is of interest to agriculturists, hydrologists, geomorphologists, and construction or radar engineers. Short-term rainfall has implication for soil moisture, field operations, electro-optical sensors, and equipment design or malfunction. Military planners are especially concerned with such information because of the impact of rain on mobility and trafficability. Data for rain accumulations over short periods of time are usually not available. Routine climatic precipitation data for much of the world consist of the average monthly and/or annual total amounts of rain and the corresponding number of rain days.

The principal objective of this study is to provide simple analytical methods for recovering the frequency distributions of any short-term rainfall. The required data are the total rainfall for a given period of time and the actual duration of the rain in days, hours, or minutes for estimating daily, hourly, or instantaneous rainfall, respectively. Average annual hourly rainfall may be estimated at times as a function of mean annual temperature. Instantaneous rainfall is limited in this study to 1-hour storms or rainy periods within storms.

Two rainfall models are provided. The first, the general model, is based mainly on a particular skew distribution that was found previously to represent rainfall under very diverse conditions. This model recovers a considerable range of information for almost any rainfall occurrence. The second, or explicit, model is specific for a given average rain rate. The latter model may be utilized for situations not covered by the general model or as an alternate method. In contrast to certain of the earlier techniques, the above models (a) depend on viable rainfall mass distribution for the situation at hand and (b) determine

short-term rainfall, first with respect to the percent frequency of the total duration of the rain and then with respect to real time.

The results yield reasonably accurate short-term rain rates for nearly 98 percent of the rain period. Either model readily determines the percent of time the average rain rate or any selected rain rate is equalled or exceeded. Of significance is the fact that the mean daily, hourly, or instantaneous rain intensity for any duration tends to be greatly exceeded for at least 5 percent of the time. The graphs and computer programs given not only facilitate the rapid estimation of short-term rainfall for almost any situation, but also serve to improve understanding of short-term rainfall spectra.

ETL-0442

AD-A183 370

**CLASSIFICATION OF SELECTED RADAR IMAGERY PATTERNS
USING A BINARY TREE CLASSIFIER
October 1986**

Fox, Neil D.

Keywords: Binary Decision Tree, Bayes Classifier, Radar Imagery, Feature Selection

This report details the results of classifying radar imagery using a binary tree classifier. It was found that this classification algorithm works well with radar imagery, which would indicate a normal (Gaussian) feature vector distribution. The number of elements in each feature vector is the limiting factor; classification time is negligible once the tree structure has been created.

ETL-0443

AD-A183 537

**PATTERN CLASSIFICATION TECHNIQUES APPLIED TO HIGH
RESOLUTION, SYNTHETIC APERTURE RADAR IMAGERY
November 1986**

Hevenor, Richard A.
Chen, Pi-Fuay

Keywords: Radar Imagery, Pattern Recognition

This report describes the application of 10 pattern classification techniques to selected samples of high resolution, synthetic aperture radar imagery taken over the Huntsville, Alabama, area. Sections of the radar imagery were digitized and stored on a digital disk unit. A Lexidata system 3400 image processor and a Hewlett Packard 1000 computer were used to display the images on a cathode ray tube and to take 100 samples for each of four terrain classes from the imagery. The 400 image samples were then used as training sets to derive the 10 classifiers. Once the classifiers were derived, the training set data were then used as input to the classifiers to see how well each would do in classifying the original training sets.

ETL-0444

AD-B107 142L

**RESEARCH IN KNOWLEDGE-BASED VISION TECHNIQUES
FOR THE AUTONOMOUS LAND VEHICLE PROGRAM
September 1986**

Nevatia, R.
Price, K.

University of Southern California

DACA76-85-C-0009

Keywords: Autonomous Land Vehicle, Motion Analysis, Target Detection and Description, Knowledge-Based Vision

This report describes our research in motion analysis and estimation techniques for the period of June 1, 1985 to May 31, 1986. This research is of particular relevance to the DARPA Autonomous Land Vehicle (ALV) program, but should also be of other general utility.

Our approach to detecting and tracking motion is to extract and match features, such as lines and regions, from a sequence of images. We present two matching techniques with some results.

We also present two methods for 3-D motion estimation from 2-D image correspondences. One of our methods uses more than two frames; under some assumptions of constancy of motion, the analytical solution is simplified and also shown to be robust to noise.

Our motion detection and estimation techniques exist as separate modules at this time and are not integrated into a complete system. We are currently working on such integration.

ETL-0445

AD-A174 786

**DOMAIN-DEPENDENT REASONING FOR VISUAL
NAVIGATION OF ROADWAYS
October 1986**

LeMoigne, Jacqueline

University of Maryland

DACA76-84-C-0004

Keywords: Autonomous Navigation, Road Following, Computer Vision

A Visual Navigation System for Autonomous Land Vehicles has been designed at the Computer Vision Laboratory of the University of Maryland. This system includes several modules, among them a "Knowledge-Based Reasoning Module" that is described in this report. This module utilizes domain-dependent knowledge (in this case, "road knowledge") in order to analyze and label the visual features extracted from the imagery by the Image Processing Module. Knowledge and general hypotheses are given in section 2. The Reasoning Module itself is described in section 3 and results are presented in section 4. Finally, some conclusions and future extensions are proposed in Section 5.

ETL-0446

AD-A183 773

**A USER'S GUIDE FOR THE ANALYTICAL PHOTOGRAMMETRIC
POSITIONING SYSTEM (APPS)
November 1986**

Newbury, George E.

Keywords: Remote Sensing, Analytical Photogrammetric Positioning System (APPS), Stereo Imagery, Stereoplotter

The purpose of this report is to describe the Analytical Photogrammetric Positioning System (APPS) and the Automated Geographic Information System (AUTOGIS). The report describes the recommended approach for using the hardware and software, and gives some examples of projects that may make use of the systems.

ETL-0447

AD-A174 794

**DEVELOPMENT OF ELECTRONIC CONTROL OF A SUPERCONDUCTING
GRAVITY GRADIOMETER -- PHASE II
November 1986**

Paik, H. J.

University of Maryland

DACA72-85-C-0010

Keywords: Gravity Gradiometer, Gravity Survey, Inertial Navigation

During the contract period, we have completed the design and assembly of the breadboard feedback circuit for the new NASA superconducting gravity gradiometer. The circuit applies three kinds of feedbacks to the gradiometer instrument: (1) high frequency rejection, (2) cold camping, and (3) force rebalance. The primary purpose of these feedbacks is to increase the dynamic range of the instrument. The circuit has been tested at room temperature and is awaiting a test in connection with the actual gradiometer.

ETL-0448

LOCAL GRAVITY FIELD MODELING
December 1986

Rose, Eugene J.

Keywords: Deflection of the Vertical, Digital Terrain Models, Collocation, Geoid, Geoid Undulation, Geodesy, Gravity, Isostasy, Spherical Harmonics

In this report, an experiment is described wherein a local gravity field model was computed in mountainous terrain using digital terrain data, spherical harmonic coefficients, and local observations. The accuracies of free air gravity anomalies, deflections of the vertical, and geoid undulations computed are discussed.

ETL-0449

AD-B114 172L

SOFTWARE SYSTEM DESCRIPTION FOR MINEFIELD SITE
PREDICTION EXPERT SYSTEM
February 1987

Barth, Stephen
Downs, Anne L.
Long, Orrin
Stock, James A.

Par Government Systems Corporation

DACA72-86-C-0017

Keywords: Expert System, Minefield Site Prediction, Terrain Analysis, Quadtree

This document describes the software system for a Minefield Site Prediction Expert System. The three major components of this system are the expert system, the user interface, and the data base. The main software interfaces described are the Explanation Interface, Advice Interface, Graphic Display Interface, and Attribute Manager.

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM,
THIRD QUARTERLY REPORT
November 1986**

Lowrie, James

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Autonomous Navigation, Computer Vision, Road Following

The report covers problems and progress on the Autonomous Land Vehicle (ALV) Project at Martin Marietta Denver during the third quarter of 1986, approximately July to November, and summarizes plans for the fourth quarter. In the third quarter, the 1986 Technical Status Review (TSR) was successfully accomplished. The TSR demonstrated perceptual fusion of color video and laser range data for obstacle detection and description (object model), local trajectory planning for obstacle avoidance (using the Martin Marietta Corporation planner and Advanced Decision Systems planner), and obstacle detection at 3 Kph with road following at 17.5 Kph. Prototyping of the hardware components for the new 1987 computer hardware and Local Area Network architecture was initiated. The preliminary design and organization of the Perceptual and Reasoning software subsystems to be implemented on the 1987 architecture was completed.

**DEVELOPMENT OF COMPUTER VISION TECHNIQUES
FOR AUTOMATIC FEATURE EXTRACTION**

January 1987

Gordon, Daniel K.
Pascucci, Richard F.

Autometric, Incorporated

Keywords: Computer Vision, SAR Imagery, Descriptor Sets, Automatic Feature Extraction, Expert System

In previous work, 52 descriptors (feature identifiers) and 501 descriptor sets were identified as being used by image analysts for the characterization of features found in radar imagery. In the research investigation described herein, the descriptor sets were tested and validated. Following this, computer vision techniques were identified and developed to automatically recognize these descriptor sets. The identification procedure includes image preprocessing (e.g. edge enhancement, density slicing, neighborhood encoding and thinning), raster to vector conversion, and the processing of the resultant vector data (e.g. identification of points, lines, and areas, referred to as primitives, including a description of primitive size, shape, position, and orientation). Finally, the relative positions of primitives were examined, and the similarity between groups of primitives and descriptor sets was quantified. The images used were softcopy versions of graphic, line-drawn examples of the descriptors that were identified in the previous work. The computer vision techniques that were developed have been demonstrated successfully, in a tightly controlled environment, on images containing little extraneous information. Research is currently being expanded to include carefully selected, uncluttered radar examples. The final goal of the investigation is the automatic identification of selected features from images acquired under a variety of conditions.

ETL-0452

AD-A184 075

**TWO DIMENSIONAL PATH PLANNING WITH OBSTACLES
AND SHADOWS**

January 1987

Puri, Sunil
Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Robotics, Navigation, Path Planning, World Modeling, Vision

A mobile robot navigates with a limited knowledge of its environment because of the restricted field of view and range of its sensors, and the occlusion of parts of the environment in any single image. Most path planning algorithms consider only free regions and obstacles in the robot's world for path planning. The objective of this report is to extend the classical path planning paradigm to include occluded regions. This introduces the new problem of deciding when (or whether) to employ the sensor system during the execution of the path to, potentially, reveal the occluded regions as obstacles or free space for the purpose of replanning.

ETL-0453

AD-A183 754

SHAPE FROM PROJECTING A STRIPE PATTERN

January 1987

Asada, Minoru
Tsuji, Saburo

University of Maryland

DACA76-84-C-0004

Keywords: Computer Vision, Robot Vision, Stereo Vision, Surface Orientation

This paper presents a simple method which determines the shape of an object by projecting a stripe pattern onto it. Assuming orthographical projection as a camera model and parallel light projection of the stripe pattern, the method obtains a 2(+)D representation of objects by estimating surface normals from the slopes and intervals of the stripes in the image. The 2(+)D image is further divided into planar or singly curved surfaces by examining the distribution of the surface normals in gradient space. Some applications and evaluation of the error in surface orientation are described.

ETL-0454

AD-A183 756

**ON COMPUTING HISTOGRAMS OF IMAGES IN LOG η TIME
USING FAT PYRAMIDS
February 1987**

Bestul, Thor
Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Histogram Computation, Hypercube, Pyramid Algorithm, SIMD Multi-processor

This paper presents an algorithm for the log η computation of the complete histogram of an $\eta \times \eta$ gray-level image. It uses a "fat" pyramid implemented on an SIMD hypercube multiprocessor with very high processor utilization. A "fat" pyramid is a pyramid in which the size of a processor associated with a node in the pyramid depends on the level of the pyramid in which the node appears. We describe how to embed fat pyramids in hypercubes using Gray Codes, and then describe the histogramming algorithm.

ETL-0455

**IRS: A SIMULATOR FOR AUTONOMOUS LAND
VEHICLE NAVIGATION
July 1987**

Veatch, Phillip A.
Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Computer Simulation, Navigation, Path Planner, Range Image, Vision

IRS is a computer simulation program that provides a software testbed for autonomous navigation algorithms. The program allows the user to describe a complex world built from spheres, parallelepipeds, planar surfaces, cones, and cylinders. The program simulates the movement of an Autonomous Land Vehicle and constructs video and range images based on the ALV's field of view as the vehicle moves through the world. Ground maps of the world, as perceived by the ALV, are also created.

ETL-0456

AD-A183 755

PARALLEL ALGORITHMS FOR COMPUTER VISION
January 1987

Poggio, Tomaso
Little, James

Massachusetts Institute of Technology

DACA76-85-C-0010

Keywords: Computer Vision, Connection Machine, Parallel Algorithms

The general goals of this research effort is to explore the potential applications and performance of fine grained computer architectures for vision. The body of this report gives a brief overview of the results of the research during the first 12 months of effort. A taxonomy of parallel vision algorithms has been refined. Parallel versions of several Class 1 algorithms (for early vision, directly derived from regularization methods) have been designed. This preparatory work allowed the implementation of several of these algorithms on the Connection Machine within a few days when it became available to the researchers. Class 2 and 3 algorithms have also been designed, while at the same time studying some of the associated basic problems in recognition and representation.

ETL-0457

AD-A183 859

**A PROGRAMMING ENVIRONMENT FOR PARALLEL
VISION ALGORITHMS**
February 1987

Brown, Christopher

University of Rochester

DACA76-85-C-0001

Keywords: Parallel Processors, Butterfly Computer, Computer Vision

During the second year of the award period, the Computer Science Department of the University of Rochester continued work in: 1) systems support algorithms, 2) the Butterfly programming environment, and 3) vision applications. This research produced several internal and external reports as well as much exportable code. The University of Rochester also employed DARPA Parallel Architecture Benchmark problems to test different algorithms using four different Butterfly programming environments. These tests produced several interesting results and demonstrated that the Butterfly architecture is a flexible general purpose architecture that can be effectively programmed by non-experts, using tools developed at BBN and Rochester. The University of Rochester is continuing to study the issues and concerns surrounding the effective implementation of parallel algorithms.

ETL-0458

AD-A188 184

**A SMART MAPPING, CHARTING AND GEODESY CONTROL
GENERATOR, PHASE I
March 1987**

Leberl, Franz W.
Kober, Woody
Harjes, Mark F.

VEXCEL Corporation

DACA72-86-C-0008

Keywords: Image Registration, Geographic Information Systems, Automated Control Generation

The real-time automated registration of multi-sensor imagery begins with the generation of control information. A specific application may require the registration of newly acquired data to an existing spatial data base (absolute registration), or to other images of a series (relative registration). This study examines the feasibility and upper-level design of a system capable of providing the control information required for a range of image registration tasks and image types. In general, we suggest that the control generator will be guided by a spatial data base maintaining information about the feature content of the area of interest. A rule-based query generator will extract candidate ground control optimized for the particular image type and geometry at hand.

ETL-0459

AD-B113 994L

**AUTOMATED INDUSTRIAL FEATURE EXTRACTION FROM
SYNTHETIC APERTURE RADAR IMAGERY
April 1987**

Lambird, B.
Lavine, D.
Josephs, M.

LNK Corporation

DACA72-86-C-0012

Keywords: Artificial Intelligence, Image Understanding, Expert Systems, Synthetic Aperture Radar Image Analysis

LNK Corporation investigated the feasibility of automatic extraction of military industrial features from SAR (Synthetic Aperture Radar) imagery. LNK implemented an interactive, general Image Processing System (IPS) on a SUN-3 Workstation and demonstrated promising results on a few industrial features, using a combination of image processing and artificial intelligence techniques. The use of rules and structural models was demonstrated on the extraction of large buildings. Quick preprocessing steps for three other industrial features (breakwaters, parking lots with lights, and POL tanks) were devised to isolate likely candidates for each of these features. The Phase I results were generally very promising. A design for an industrial feature extraction system is presented. It combines image processing with two artificial intelligence techniques: rule-based expert systems and a novel structural modeling technique developed by LNK Corporation.

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM,
FOURTH QUARTERLY REPORT
February 1987**

Koenig, Rainer

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Computer Vision, Obstacle Detection, Obstacle Avoidance, Artificial Intelligence, Image Understanding, Knowledge Representation, Strategic Computing (SC)

The Autonomous Land Vehicle (ALV) Fourth Quarterly Report covers program activities and progress made during the period from 1 Dec 86 through 28 Feb 87. During this period, efforts concentrated on developing, prototyping, and testing concepts and components of the 1987 ALV vehicle and computer lab computer hardware architecture. A program critical design review (CDR) was held between 3-4 February 1987, to focus on the evolving architecture. The report includes the progress and status of several program research and development activities, including the design of the initial increment configuration of the reduced 87 computer hardware architecture; the modification and improvement of the vehicle platform and body shell; the Vehicle-Lab communication subsystem; plans for future integration of a FLIR sensor; ultrasonic obstacle detection and avoidance sensor testing; Perception, Reasoning, Utilities, and Data Transport (LAN) software design developments; the status of becoming an ARPANET subscriber; and a summary of the December 1986 ALV Program Quarterly Review meeting, held in Key West, Florida, which highlighted the military applications of autonomous land vehicle technology.

ETL-0461

AD-A185 421

**RANGE IMAGERY ALGORITHMS FOR THE DETECTION OF
OBSTACLES BY AUTONOMOUS VEHICLES**

July 1987

Veatch, Phillip A.
Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Image Segmentation-Range, Autonomous Navigation

Algorithms are presented which segment range images and classify regions as being navigable or unnavigable by a land vehicle. The algorithms are applied to data collected from an active laser range sensor mounted on an autonomous land vehicle and their comparative results are analyzed. The sensitivity of various algorithms to uncertainty in the orientation of the range sensor is studied. Experiments on sensor calibration and image enhancement are also presented. A computer model of an autonomous land vehicle and its environment is described which provides a valuable tool for investigating many issues of navigation with range sensors. Obstacle detection algorithms are used in conjunction with the model to demonstrate a vehicle navigating itself through an obstacle-strewn world to a goal location.

ETL-0462

AD-A184 246

**A TIGHT UPPER BOUND FOR THE SPEED-UP OF
PARALLEL BEST-FIRST BRANCH-AND-BOUND ALGORITHMS**

May 1987

Huang, Shie-rei
Davis, Larry S.

University of Maryland

DACA76-84-C-0004

Keywords: Butterfly Multiprocessor, Combinatorial Search, Operations Research, Parallel Algorithm, Queueing Model

Most previous studies of the speedup of parallel branch-and-bound algorithms are based on the amount of work done in the parallel case and in the sequential case. Any evaluation of a parallel algorithm should include both the execution time and the synchronization delay. In this paper, a finite population queueing model is used to capture the synchronization delay in parallel branch-and-bound algorithms and to quantitatively predict the behavior of their speedup. A program to solve the Traveling Salesman Problem was written on a BBN Butterfly multiprocessor to empirically demonstrate the credibility of this theoretical analysis. Finally, we note that similar analyses can be applied to evaluate parallel AI systems in which processes communicate through a shared global data base.

**END OF YEAR TECHNICAL REPORT: DYNAMIC IMAGE
INTERPRETATION FOR AUTONOMOUS VEHICLE NAVIGATION
May 1987**

Riseman, E. M.
Hanson, A. R.
Kitchen, L. J.

University of Massachusetts

DACA76-85-C-0008

Keywords: Scene Interpretation, Sensor Motion, Spatial Reasoning

This report describes work conducted at the University of Massachusetts for the Autonomous Land Vehicle Project (under contract DACA76-85-C-0008) during the 1-year period from February 26, 1986 to February 25, 1987. In pursuit of the goal of achieving dynamic image interpretation for autonomous vehicle navigation, we have made significant progress in the knowledge-based interpretation of road scenes, in visual motion analysis, and in mobile robot navigation. This work has been supported by development of necessary software tools, installation of appropriate hardware, and concurrent investigations into applicable techniques for image analysis.

**1986 YEAR END REPORT FOR ROAD FOLLOWING
AT CARNEGIE-MELLON
May 1987**

Thorpe, Charles
Kanade, Takeo

Carnegie-Mellon University

DACA76-85-C-0003

Keywords: Mobile Robots, Computer Vision, Autonomous Navigation

This report describes progress in vision and navigation for outdoor mobile robots at the Carnegie-Mellon Robotics Institute during 1986. This research was sponsored by DARPA as part of the Strategic Computing Initiative. Our work during 1986 culminated in two demonstration systems. The first system drives the Terregator, a desk-sized robot with six wheels, around the network of campus sidewalks. This system, named Sidewalk II, uses a video camera to follow sidewalks and a laser rangefinder to detect and avoid stairs. Sidewalk II makes extensive use of map data, for visual predictions and for path planning.

The second system, Park Navigation, uses the Navlab, our new Chevrolet Van robot. The Park system concentrated on vision for following difficult roads, including curves, dirt and leaves, shadows, puddles, and both moving and fixed obstacles.

We developed vision techniques for handling difficult roads, and built range finder programs for detecting and avoiding obstacles.

Both the Sidewalk II and Park experiments were built into complete systems using CODGER, a novel whiteboard developed as part of the project. CODGER provides tools for handling geometry, motion over time, multiple processes, and multiple languages.

This report is divided into four main sections. Section 1 is an introduction and overview, including a chronology for the project and a list of 1986 publications. Section 2 describes the Sidewalk II system; section 3 describes the Park experiments; and section 4 is about CODGER.

ETL-0465

AD-A184 243

AUTONOMOUS LAND VEHICLE (ALV) PLANNING AND NAVIGATION SYSTEM
April 1987

Keirse, D. M. Tseng, D. Y.
Mitchell, J. S. B. Wong, V. S.
Payton, D. W. Zikan, K.

Hughes Aircraft Company

DACA76-85-C-0017

Keywords: Autonomous Vehicles, Route Planning, Hierarchical Planning, Terrain Navigation, Mobile Robots

The Hughes planning system is designed to achieve the reasoning requirements of the Autonomous Land Vehicle (ALV) for navigation in unconstrained outdoor environments. This system is designed specifically to handle diverse terrain with maximal speed, efficacy and versatility. The hierarchical architecture for this system is presented along with the detailed algorithms, heuristics, and planning methodologies for the component modules. The architecture is structured such that lower-level modules perform tasks requiring greatest immediacy while higher-level modules perform tasks involving greater assimilation of sensor data, making use of large amounts of *a priori* knowledge.

This report documents the first year of progress under contract to DARPA for the Planning and Navigation System for ALV. It includes a discussion of the technical design of the multi-level planning system and its component modules. Specific details of progress made in developing map-based planning capabilities for the Martin Marietta test area, simulation capabilities to support development of real-time sensor-based motion planning, and several reflexive behaviors and virtual sensors which provide basic road following and obstacle avoidance capabilities.

ETL-0466

CMU STRATEGIC COMPUTING VISION PROJECT REPORT: 1984 to 1985
August 1987

Kanade, Takeo
Thorpe, Charles

Carnegie-Mellon University

DACA76-85-C-0003

Keywords: Computer Vision, Robots, Autonomous Navigation, Road Following

This report is a broad overview of the CMU Strategic Computing Vision Project. The goal of the SCVision project at CMU is to build vision and intelligence for an intelligent mobile robot capable of operating in the real world outdoors. CMU is attacking this on a number of fronts, ranging from building appropriate research vehicles to exploiting high-speed experimental computers to building software for reasoning about the perceived world. This is a progress report rather than a discussion of complete scientific results: some of what is presented is more pragmatic than scientific, and much of the research is still in preliminary stages.

**END OF YEAR REPORT FOR PARALLEL VISION ALGORITHM
DESIGN AND IMPLEMENTATION
May 1987**

Kanade, Takeo
Webb, Jon A.

Carnegie-Mellon University

DACA76-85-C-0002

Keywords: Computer Vision, Parallel Algorithms, Warp

This report describes progress for the parallel vision algorithm design and implementation effort at Carnegie-Mellon University for 1986. The goals that were accomplished include several demonstrations of Warp's use for road following, obstacle avoidance using stereo vision and ERIM laser range scanner data, NMR image processing, signal processing, and other vision algorithms. A vision library for low-level vision algorithms, all written in the Warp programming language (W2) was compiled. A specialized programming language called Apply was developed for programming low-level vision algorithms on Warp. Finally, the report describes the first use of Warp as a tool for research into vision algorithms, as opposed to purely being used as a tool for research into parallelism.

ETL-0468

AD-B117 853L

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM,
FIFTH QUARTERLY REPORT
August 1987**

Hoyer, Gustav R., Editor

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Autonomous Land Vehicle, Robotics, Image Understanding, Unmanned Vehicles, Artificial Intelligence, Computer Vision Processing

The Autonomous Land Vehicle (ALV) Fifth Quarterly Report covers program activities from February 28, 1987, to May 31, 1987. During this period the ALV vehicle improvement program was completed. Upon delivery of the modernized vehicle, the remaining interior finishing work was completed on the electronic racks, the computer room-style floor, and operator's console. Following this, installation of exterior sensors and communications antennas was accomplished. A new power distribution system and associated wiring was installed. Initial installation of the components of the 1987 computer hardware architecture was begun. Work on the new vehicle-lab local area network (LAN) interface panel and cabling was begun. A summary describing the computer hardware configuration of the ALV lab is presented in this report. The status of the installation work on the DARPA satellite video conferencing system is summarized. A feature article describes the ALV test area and road track at the Martin Marietta Denver Aerospace plant site. Software development included continued refinement and testing of Perception, Reasoning, and Control software modules in preparation for the 1987 Demonstration Readiness Review.

ETL-0469

**LINEAR FEATURE EXTRACTION FROM RADAR IMAGERY,
SBIR PHASE II BASE CONTRACT
July 1987**

Connor, Gary D.
Lawton, Daryl T.

McConnell, Christopher C.
Milgram, David L.

Advanced Decision Systems

DACA72-86-C-0004

Keywords: SAR, Feature Extraction, Edge Detection, Terrain Analysis, Image Understanding

The goal of this effort is to develop and demonstrate prototype processing capabilities for a knowledge-based system to automatically extract and analyze linear features from synthetic aperture radar (SAR) imagery. This effort constitutes Phase II funding through the Defense Small Business Innovative Research (SBIR) Program. Previous work examined the feasibility of and technology issues involved in the development of an automated linear feature extraction system. The current effort continues this examination and is developing the technologies involved in automating this image understanding task.

ETL-0470

AD-A185 717

**TERRAIN ANALYST WORK STATION (TAWS):
1AD AFTER ACTION REPORT
August 1987**

Quick, John, Maj.
Greczy, Laslo
Musser, Eric, Capt.
Carroll, Roberta

Ference, David
Hardaway, Michael G.
Jarrett, Joni
Porter, Liz

Keywords: Terrain Analysis, Automated Terrain Analysis, Terrain Analyst Work Station (TAWS)

At the request of the 1st Armored Division (1AD), the Engineer Topographic Laboratories visited 1AD and demonstrated the Terrain Analyst Work Station (TAWS), demonstrated its capabilities, and provided products for 1AD's area of interest. This after action report describes the TAWS, its capabilities, and the training performed; and reports the comments provided by 1AD and others about the TAWS and products provided.

ETL-0471

**3-D ROAD STRUCTURE FROM MOTION STEREO
April 1987**

Asada, Minoru

University of Maryland

DACA76-84-C-0004

Keywords: Computer Vision, 3-D Shape Recovery, Motion Stereo

This paper presents a new method for reconstructing the 3-D structure of road boundaries from consecutive images. First, we present a method for estimating depth information by applying a motion stereo method to consecutive images, given an estimate of the interframe motion. The relation between depth, motion and disparity is investigated, since the accuracy of the depth depends on the disparity range. Next, the error of the estimated road structure due to quantization errors and motion estimation errors is examined. Finally, a representation for road boundaries is proposed that makes explicit the error of the road edge location in 3-D space. Experimental results are shown for an input image sequence taken by the ALV simulator robot in the Center for Automation Research at the University of Maryland.

**CONTOUR-TO-GRID INTERPOLATION WITH NONLINEAR
FINITE ELEMENTS: A FEASIBILITY STUDY
September 1987**

Witzgall, Christoph
Bernal, Javier
Mandel, Betty

National Bureau of Standards

Keywords: Cartography, Clough-Tocher Element, Contour Line, Delaunay Diagram, Digitized Data, Finite Element Method, Line Generalization, Surface Interpolation, Synthetic Surface, Terrain Modeling, Thiessen Diagram, Tolerance Band, Triangulation, Voronoi Diagram.

The U.S. Army Engineer Topographic Laboratories and the National Bureau of Standards investigated the computational feasibility of developing a contour-to-grid algorithm by: (1) sampling a large set of digitized cartographic contour data with a tolerance band technique, (2) its subsequent triangulation with a Voronoi (Delaunay, Thiessen) method, and (3) the construction of an interpolating smooth synthetic surface from which grids can be generated at any given interval. This report presents a discussion on the results obtained.

**AUTOCORRELATION OF CONTROL POINTS ON 11-BAND
MULTISPECTRAL IMAGERY
August 1987**

Rand, Robert S.

Keywords: Autocorrelation Measures, Image Registration, Multispectral Imagery, Feature Extraction, Image Segmentation Algorithms

The use of multispectral imagery with other types of imagery requires that the combined set be accurately registered. This study investigates correlation properties between bands of an 11-channel multispectral scanner for 37 control points in support of interband registration that can later be extended to dissimilar image registration. The results show a high degree of correlation between channel 1 through 7, but a lower and unpredictable correlation for other combinations. In addition to providing information about interband registration, the results also have implications for multispectral segmentation algorithms.

ETL-0474

AD-A190 212

**CLIMATIC INFORMATION FOR APPLICATION IN DESIGNING
AND TESTING U.S. ARMY MATERIEL
September 1987**

Niedringhaus, Thomas E.

Keywords: Climate, Climatic Criteria, Climatic Design Types, Daily Weather Cycles, Climatic Elements, Climatic Extremes, Temperature, Humidity, Solar Radiation

This report provides values and other information for the application of extreme climatic conditions in the RDT&E of Army materiel. Values are given for operational conditions and storage and transit conditions. The two sets of climatic criteria are necessary in order to satisfy requirements that equipment be capable of specified performance levels under all but the most severe natural climatic conditions, and that equipment can survive the most severe-expected induced climatic conditions for long periods of time without losing the specified performance capabilities when the more benign natural conditions return.

Climatic criteria are provided for four climatic design types: hot, basic, cold, and severe cold. Each of these design types is represented by one or more daily weather cycles of temperature, solar radiation, and humidity. Anticipated extreme levels for additional environmental elements (rain, snow, icing phenomena, wind, sand and dust, ozone concentration, freeze-thaw, and atmospheric pressure) are also provided. A map of the areas of occurrence of climatic design types is included to illustrate the distribution of climatic conditions for which criteria are provided.

ETL-0475

AD-A179 409

**DETERMINING THE TRANSLATION OF A RIGIDLY MOVING
SURFACE, WITHOUT CORRESPONDENCE
January 1986**

Aloimonos, John
Basu, Anup

University of Rochester

DACA76-85-C-0001

Keywords: Motion, Multiple Cameras, Texture, Correspondence

A method is presented for recovery of the three-dimensional translation of a rigidly moving textured object. The novelty of the method consists of the fact that four cameras are used in order to avoid the solution of the correspondence problem. The method seems to be immune to small noise percentages and to have good behavior when the noise increases.

ETL-0476

AD-A183 328

OBSERVATIONS ON MULTI-PEG TOWERS OF HANOI
July 1986

Newman-Wolfe, Richard

University of Rochester

DACA76-85-C-0001

Keywords: Towers of Hanoi Problem

A generalization of the classic Towers of Hanoi problem permitting additional work pegs is considered. While the idea is not original, this form of generalization has not appeared in published literature to my knowledge. Several upper bounds and lower bounds are presented for various ranges of extra work pegs, improving on the work of Gacs. A general methodology of attack is also given, producing exact results in many cases.

ETL-0479

AD-A188 186

**AN OVERVIEW OF VISION-BASED NAVIGATION FOR
AUTONOMOUS LAND VEHICLES 1986**
April 1987

Chandran, Sharat
Davis, Larry S.
DeMenthon, Daniel
Dickenson, Swen J.

Gajulapalli, Suresh
Huang, Shie-Rei
Kushner, Todd R.
LeMoigne, Jacqueline

Puri, Sunil
Siddalingaiah, Tharakesh
Veatch, Phillip

University of Maryland

DACA76-84-C-0004

Keywords: Vision-Based Navigation, Parallel Algorithms

This report describes research performed during the first two years on the project "Vision-Based Navigation for Autonomous Vehicles" being conducted under DARPA support. The report contains discussion of four main topics: (1) development of a vision system for autonomous navigation of roads and road networks; (2) support of Martin Marietta Aerospace, Denver, the integrating contractor on DARPA's ALV program; (3) experimentation with the vision system developed at Maryland on the Martin Marietta ALV; (4) development and implementation of parallel algorithms for visual navigation on the parallel computers developed under the DARPA Strategic Computing Program-specifically, the WARP systolic array processor, the Butterfly, and the Connection Machine.

ETL-0480

AD-A186 920

AUTOMATED ROUTE FINDER FOR MULTIPLE TANK COLUMNS
September 1987

Benton, John R.

Keywords: Artificial Intelligence, Heuristic Search, Route Planner, IPB (Intelligence Preparation of the Battlefield)

The Automated Route Finder for Multiple Tank Columns computes multiple non-competing paths for columns of tanks. The network of available paths is represented by a graph-theoretic structure. Each arc of the graph has an associated cost which represents the time required to traverse the path corresponding to the arc. A best-first algorithm is used to search the graph in order to find the specified number of optimum paths. The algorithm was implemented on the Symbolics LISP Machine with a color monitor used to display the graph as it is explored. Sample outputs of route finding are included with an analysis of the results. Future enhancements for the system are outlined.

ETL-0481

AD-B117 266L

**INTRODUCTION TO THE TERRAIN EFFECTS ON THE INTELLIGENCE
PREPARATION OF THE BATTLEFIELD (IPB)**
September 1987

Mintzer, Olin W.

Keywords: Intelligence Preparation of the Battlefield, Terrain Analysis, Effects of Terrain

This study correlates the effects of terrain with the Intelligence Preparation of the Battlefield (IPB). The five IPB steps are included but the attention is focused on the third step: terrain.

ETL-0482

**RESEARCH IN KNOWLEDGE-BASED VISION TECHNIQUES
FOR THE AUTONOMOUS LAND VEHICLE PROGRAM**

June 1987

Editors:
Nevatia, R.
Price, K.

University of Southern California

DACA76-85-C-0009

Keywords: Autonomous Land Vehicle, Motion Analysis, Target Detection and Description, Knowledge-Based Vision

This report describes our research in motion analysis and estimation techniques for the period of June 1, 1986, to May 31, 1987. This research is of particular relevance to the DARPA Autonomous Land Vehicle (ALV) program, but should also be of other general utility. Our basic approach to detecting and tracking motion is to extract and match features, such as lines and regions, from a sequence and to generate motion estimates from these. We present one report on matching connected line segments (contours) in a sequence of views. This work assumes relatively small motions between views.

Two approaches to motion based segmentation or grouping are also presented. We also present more results from the general 3-D motion estimation program and discuss a basic integrated system that combines feature extraction, matching and motion estimation.

ETL-0483

AD-B119 403L

**THE AUTONOMOUS LAND VEHICLE (ALV) PROGRAM,
SIXTH QUARTERLY REPORT
November 1987**

Hoyer, Gustav R., Editor

Martin Marietta, Denver Aerospace

DACA76-84-C-0005

Keywords: Autonomous Land Vehicle, Robotics, Image Understanding, Unmanned Vehicles, Artificial Intelligence, Computer Vision Processing

The Autonomous Land Vehicle (ALV) Sixth Quarterly Report covers program activities between May 31 and August 31, 1987. During this quarter, extensive hardware and software integration activities were performed in preparation for the 1987 demonstration and Technical Status Review (TSR). In hardware developments, installation, integration and testing of all the remaining components of the 1987 reduced computer hardware architecture was completed. In software developments, the final integration, testing and validation of the 1987 Computer Software Configuration Item (CSCI) components was nearly completed. Intensive testing and validation activities focused on the performance of Perception, Reasoning, Control, and Data Transport software components in accordance with the CSCI design. We hosted a meeting of the ALV Vision Working Group on August 20. We supported a visit of personnel from the Hughes AI Center between July 6-17 and August 3-14. We began installation of the Warp Systolic Array Processor on the vehicle. We initiated plans to build a new ALV program facility with an estimated completion date of June 1988.

ETL-0484

**DEVELOPMENT OF AUTOMATIC NAMES PLACEMENT SOFTWARE
December 1987**

Freeman, Herbert

Battelle Memorial Institute

DAAG29-81-D-0100

Keywords: Artificial Intelligence, Automated Cartography, Automated Map Generation

This report describes the development of a software system intended to demonstrate the capability of automatically placing geographic names on maps. The system, which is based on the previously developed AUTOCOR and AUTONAP name placement routines, is designed to label area, line, and point features in 1:24,000 scale United States Geological Survey (USGS) Digital Line Graph (DLG) maps using names extracted from corresponding USGS Geographic Names Information System (GNIS) files. The system performs its task well provided the data in the DLG and GNIS files is of high quality. As is to be expected, the system fails in its task where the correlation between DLG features and GNIS names is unclear, ambiguous, or erroneous. The system was developed for the DEC VAX family computers running under the VMS operating system.

ETL-0485

**KNOWLEDGE-BASED VISION TECHNIQUES -- TASK B:
TERRAIN AND OBJECT MODELING RECOGNITION
December 1987**

Lawton, Daryl T.
Levitt, Tod S.
McConnell, Christopher C.
Nelson, Philip C.

Black, Michael J.
Edelson, Daniel J.
Koitzch, Kerry
Dye, John W.

Binford, Thomas O.
Chelberg, David M.
Kriegman, David J.
Ponce, Jean

Advanced Decision Systems

DACA76-85-C-0005

Keywords: Model-Based Vision System, Terrain Modeling, Schema-Based Reasoning, Perceptual Processing, Image Understanding Tools, Spatial Representation, Hypothesis Management, Navigation, Image-To-Map Matching

This report describes the development and critical components of a model-based vision system for an autonomous vehicle operating in complex, outdoor, dynamic environments using optical, laser, motion, and position sensors. The critical technologies are organized with respect to Object and Event Modeling, Perceptual Processing, Spatial Representation and Reasoning, and the Integration of work in these research areas into modular and transferable components. Key results included the following: (Editor's note: results can be seen on original DD Form 1473 in the published report).

ETL-0486

**KNOWLEDGE-BASED ANALYSIS OF SCENE DYNAMICS FOR
TARGET MOTION DETECTION, RECOGNITION, AND TRACKING
June 1987**

Bhanu, Bir

Honeywell Systems and Research Center

DACA76-86-C-0017

Keywords: Strategic Computing, Qualitative Reasoning and Modeling, Motion Detection, Tracking, Landmark Recognition, Terrain Interpretation, Dynamic Modeling and Matching, Hierarchical Symbolic Grouping, Autonomous Land Vehicle, Dynamic Scene Understanding, Estimation of Vehicle Motion, Multi-spectral Images, Computer Vision

This is the first Annual Report of Honeywell Contract on Scene Dynamics and Object Recognition (DACA76-86-C-0017) sponsored under the DARPA Strategic Computing Computer Vision Program. Our research in Scene Dynamics and Object Recognition is directed towards filling the technology gaps in developing brilliant weapons and smart munitions. The results of our research make a significant technical contribution in vision-controlled navigation/guidance of Autonomous Land Vehicles (ALV's), reconnaissance, surveillance, and other practical military applications such as search and rescue and targeting missions. The topics investigated during the first year of the contract are:

- 1) Qualitative Reasoning & Modeling for motion detection and tracking
- 2) Dynamic Model Matching for landmark recognition
- 3) Hierarchical Symbolic Grouping for interpretation of terrain

The synopsis of technical achievement in each of these technical areas is given below: (Editor's note: synopsis of these technical areas can be seen on original Form DD 1473 in the published report).

ETL-0487

KNOWLEDGE-BASED VISION TECHNIQUES
October 1987

Daily, M. J.
Harris, J. G.
Reiser, K.

Tseng, D. Y.
Olin, K. E.
Vilnrotter, F. M.

Hughes Aircraft Company

DACA76-85-C-0007

Keywords: Computer Vision, Obstacle Detection, Obstacle Avoidance, Virtual Sensors, Knowledge Representation

This report relates the progress for the second year under the KBVT contract. Efforts have been concentrated on autonomous land navigation, in particular obstacle detection and avoidance for off-road maneuvers. Section 1 is an overview of the problem, summary of approach, and the program schedule. The system architecture developed during the first year is presented in Section 2. Development of the rule-based segmentation is described in Section 3. Section 4 discusses processing of the laser range imagery and the development of the Cartesian Elevation Map. Obstacle detection is discussed in Section 5, and the World Modeling System as well as the Synthetic Scanner System are described in Section 6. Section 7 concludes with plans for the third year of technical development.

**ARMY TACTICAL TERRAIN DATA REQUIREMENTS FORECAST
(FY87-FY93)
July 1987**

Scott, David J.	Foshay, William G., Capt
Lambert, Robin B.	Messmore, Jeffrey A.
Nagel, Randall W.	Orsinger, Regis J.

Keywords: Digital Terrain Data (DTD), Data Requirements, Forecasts, Future DTD Products, Army Future Systems Requirements

This report documents the results of an initial investigation of the known and anticipated DTD requirements of the Army. The review was limited to those tactical systems with operational DTD requirements prior to FY93. FY93 was chosen as the earliest date when the Army could expect to receive Tactical Terrain Data (TTD) in volume from the DMA modernized production system. TTD is a formal recognized Army digital product designed to meet future information requirements. Subsequent investigations will focus on tactical requirements beyond FY93, as well as non-tactical requirements, e.g. training and simulation applications.

PAPERS

Baldini, Angel. "Astrogeodetic Deflections of the Vertical from Stars Observation with the Danjon Astrolabe, or Similar Instruments." 1986 American Congress on Surveying and Mapping/American Society of Photogrammetry and Remote Sensing (ASCM/ASPRS) Convention, Washington, D.C., 16-21 March 1986. AD-A166 886

Barr, Sam. "Post-Mortem Identification by Means of Comparative Image Analysis of a Tattoo Marking." International Conference on Digital Image Analysis. FBI Academy, Quantico, Virginia, 15-20 June 1986. AD-A179 567

Baussus von Luetzow, Hans. "ETL's Current and Contemplated Geodetic and Related Research and Exploratory Development Program." 10th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 7-10 October 1985.

Baussus von Luetzow, Hans. "Estimation of Gravity Vector Components from Bell Gravity Gradiometer and Auxiliary Data Under Consideration of Topography and Associated Analytical Upward Continuation Aspects." 15th Annual DOD Gravity Gradiometer Review, U.S. Air Force Academy, Colorado, 10-11 February 1987. AD-A188 146

Bernal, Javier (National Bureau of Standards). See Mandel, Betty A.

Breen, Jerry M. See Zimmermann, Bruce B.

Brierly, William B., Jr. "Digital Data Dubbing Capability." Tenth Army Topographic Conference, Fort Belvoir, Virginia, 14-16 October 1987. AD-A188 252

Caldwell, Douglas R. "Using Bar Codes to Enhance Map Products." 11th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 8-10 October 1986. AD-A179 697

Caldwell, Douglas R. "The U.S. Army Electronic Map Data (EMD) Initiative." 12th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 20-22 October 1987. AD-A188 209

Caldwell, Douglas R., and Scott, David J. "Soft Map for U.S. Army Electronic Map Background Applications." American Society of Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Fall Convention, Reno, Nevada, 4-9 October 1987. AD-A188 427

Camp, Donald M., and Nagel, Randall W. "Advanced Display System, the Single Crystal-Cathode Ray Tube (SC-CRT) Stereoviewer." 1987 American Society of Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Conference, Baltimore, Maryland, 29 March - 3 April 1987. AD-A183 683

PAPERS (continued)

Capps, Penny R. "AirLand Battlefield Environment (ALBE) Tactical Decision Aid (TDA) Demonstration Program." International GIS Symposium, Crystal City, Virginia, 15-18 November 1987. AD-A189 712

Capps, Penny R. See Tolson, Michael J.

Chen, Pi-Fuay. See Rohde, Frederick W.

DeLoach, Stephen R. "The Potential of the NAVSTAR Global Positioning System for the Corps of Engineers, Civil Works." U.S. Army Corps of Engineers Fifth Remote Sensing Symposium, Ann Arbor, Michigan, 28-30 October 1985.

Desmond, Gregory B. See Edwards, Daniel L.

Dubishar, W. Craig. See Messmore, Jeffrey A.

E-an Zen, (USGS). See Ehlen, Judy.

Eastes, John W. (USAETL); Salisbury, John W. (USGS); and Hapke, Bruce (University of Pittsburgh). "Usefulness of Weak Bands in Midinfrared Remote Sensing of Particulate Planetary Surfaces." *Journal of Geophysical Research*, 1987, Vol. 92, NOB1, pp. 702-710. AD-A179 669

Edwards, Daniel L. "CAPIR/DEM: A Collection System for Geographically Based Digital Elevation Data." Geographic Information Systems (GIS) in Government Workshop, Springfield, Virginia, 10-13 December 1985. [This paper was also presented at the 1986 American Congress on Surveying and Mapping/American Society for Photogrammetry and Remote Sensing (ACSM/ASPRS) Convention, Washington, D.C., 16-21 March 1986.] AD-A167 471

Edwards, Daniel L.; Schoppmann, Michael W.; and Desmond, Gregory B. "Terrain Data Base Generation for Autonomous Land Vehicle Navigation." International Society for Photogrammetry and Remote Sensing (ISPRS) Commission II Symposium, Baltimore, Maryland, 26-30 May 1986. AD-A187 869

Ehlen, Judy (USAETL), and E-an Zen, (USGS). "Petrographic Factors Affecting Jointing in the Banded Series, Stillwater Complex, Montana." *Journal of Geology*, 1986, Vol. 94, pp. 575-584. AD-A179 618

Golden, Robert J., 1st Lt. "Battlefield Environmental Effects Software (BEES): An Overview." 12th Annual DOD Mapping, Charting & Geodesy Conference, Cameron Station, Alexandria, Virginia, 20-22 October 1987. AD-A188 144

Greczy, Lazlo. "AirLand Battlefield Environment (ALBE) Demonstration." 11th Annual DOD Mapping, Charting & Geodesy Conference, Cameron Station, Alexandria, Virginia, 8-10 October 1986. AD-A187 975

Hapke, Bruce (University of Pittsburgh). See Eastes, John W.

PAPERS (continued)

Hardaway, G. Michael. "The Quick Response Multicolor Printer (QRMP) System." 12th Annual DOD Mapping, Charting & Geodesy Conference, Cameron Station, Alexandria, Virginia, 20-22 October 1987. AD-A188 140

Hardaway, G. Michael, and Porter, Elizabeth. "The Terrain Analyst Work Station." Geographic Information Systems (GIS) in Government Workshop, Springfield, Virginia, 10-12 December 1985. AD-A166 798

Hardaway, G. Michael. See Porter, Elizabeth.

Herrmann, Richard A. "Army Requirements for Digital Topographic Data." Eighth Annual Army Topographic Conference, Fort Belvoir, Virginia, 30 September - 2 October 1985. AD-A155 164

Hevenor, Richard. See Rohde, Frederick W.

Howard, Theodore W. "A Digital Terrain Data (DTD) Production Initiative." Tenth Army Topographic Conference, Fort Belvoir, Virginia, 14-16 October 1987. AD-A188 164

Jorgensen, Thomas. See Kurtz, Keith.

Kurtz, Keith, and Jorgensen, Thomas. "GIS-Based Applications with a Worldwide Database." Geographic Information Systems (GIS) in Government Workshop, Springfield, Virginia, 10-13 December 1985. AD-A166 825

Lambert, Robin B. See Mattson, Kathleen M.

Lane, Gerald R. (USATACOM). See Leighty, Robert D.

Leighty, Robert D. (USAETL), and Lane, Gerald R. (USATACOM). "DARPA ALV Summary." Intelligent Systems for Army Logistics Support and Combat Engineering Symposium, Fort Belvoir, Virginia, 25-27 March 1986. AD-A167 472

Leighty, Robert D. (USAETL), and Lane, Gerald R. (USATACOM). "Developing Technologies for Army Autonomous Land Vehicles." 1986 Army Science Conference, West Point, New York, 17-20 June 1986. AD-A187 972

Lukes, George E. "Automated Screening of Reconnaissance Imagery." 1986 Army Science Conference, West Point, New York, 17-20 June 1986. AD-A187 974

Lukes, George E. "A Review of Computer-Assisted Photo Interpretation Research at USAETL." SPIE Los Angeles '87 Symposium, Los Angeles, California, 16 January 1987. AD-A183 034

Lukes, George E. (USAETL), and Raggam, Hannes (Technical University and Graz Research Center). "Implementation of Map-To-Image Correspondence for Synthetic Aperture Radar Image Analysis." 1986 American Congress on Surveying and Mapping/American Society of Photogrammetry and Remote Sensing (ASCM/ASPRS) Convention, Washington, D.C., 16-21 March 1986. AD-A166 791

PAPERS (continued)

Mandel, Betty A. "AirLand Battlefield Environment (ALBE) Demonstration." 1987 American Society of Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Conference, Baltimore, Maryland, 29 March - 3 April 1987. AD-A188 426

Mandel, Betty A. (USAETL); Witzgall, Christoph; and Bernal, Javier (National Bureau of Standards). "Non-Linear Contour-To-Grid Digital Interpolation." 11th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 8-10 October 1986. AD-A180 632

Marth, Richard B. "The Terrain Analyst Work Station." 10th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 7-10 October 1985. AD-A167 473

Marth, Richard B. "Digital Topographic Support System (DTSS)." 12th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 20-22 October 1987. AD-A188 304

Mattson, Kathleen M., and Lambert, Robin B. "Fulda Gap Video Disc--A Tactical Decision Aid." 54th MORS, Fort McNair, Washington, D.C., 24-26 June 1986. AD-A187 973

Messmore, Jeffrey A., and Scott, David J. "An Army Strategy for the 1990's." 1987 American Society of Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Conference. Baltimore, Maryland, 29 March - 3 April 1987. AD-A179 569

Messmore, Jeffrey A., and Dubishar, W. Craig. "The Evolution of Tactical Terrain Data (TTD)." 12th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 20-22 October 1987. AD-A188 165

Nagel, Randall W. See Camp, Donald M.

Norvelle, F. Raye. "UNAMACE Software Improvements." 11th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 8-10 October 1986. AD-A183 684

Orsinger, Regis J. "Army Digital Terrain Requirements." Navy's Digital Mapping, Charting and Geodesy Data Testbed Interest Group. Washington, D.C., 22 June 1987. AD-A188 253

Porter, Elizabeth. "Human Factors Design Considerations for the Next Generation GIS." Geographic Information Systems (GIS) in Government Workshop, Springfield, Virginia, 10-13 December 1985.

Porter, Elizabeth. "An Overview of the Army GIS Research Program." International GIS Symposium, Crystal City, Virginia, 15-18 November 1987. AD-A189 711

PAPERS (continued)

Porter, Elizabeth, and Hardaway, G. Michael. "The Terrain Analyst Work Station." Third National MOSS Users Workshop, Fort Collins, Colorado, 2-5 June 1986.

Porter, Elizabeth. See Hardaway, G. Michael.

Opitz, Bruce. See Quick, John, Maj.

Quick, John, Maj., and Opitz, Bruce. "New Topographic Material Update." 11th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 8-10 October 1986. AD-A179 613

Raggam, Hannes (Technical University and Graz Research Center). See Lukes, George E.

Rinker, Jack N. See Satterwhite, Melvin R.

Rohde, Frederick W. "Radar Descriptors for the Classification of Terrain Features." 1986 Army Science Conference, West Point, New York, 17-20 June 1986. AD-A188 145

Rohde, Frederick W.; Chen, Pi-Fuay; and Hevenor, Richard. "Automated Radar Image Analysis Research in Support of Military Needs." 11th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 8-10 October 1987. AD-A179 615

Rose, Barbara. "The Feasibility of Automating Rapid Response Terrain Analysis Studies." 1987 American Society of Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Conference, Baltimore, Maryland, 29 March - 3 April 1987. AD-A188 458

Rosenthal, Richard L. See Zimmermann, Bruce B.

Salisbury, John W. (USGS). See Eastes, John W.

Satterwhite, Melvin R., and Rinker, Jack N. "Effect of the Reflectance Spectra of Vegetation and their Digital Classification." 1986 Army Science Conference, West Point, New York, 17-20 June 1986. AD-A188 143

Schoppmann, Michael W. See Edwards, Daniel L.

Scott, David J. See Caldwell, Douglas R.

Scott, David J. See Messmore, Jeffrey A.

Sither, Mark A. "Terrain Analyst Work Station (TAWS) Demonstrations." 1987 American Society of Photogrammetry and Remote Sensing/American Congress on Surveying and Mapping (ASPRS/ACSM) Conference, Baltimore, Maryland, 29 March - 3 April 1987. AD-A188 139

PAPERS (continued)

Straub, Michael C. "The Quick Response Multicolor Printer (QRMP) System." Tenth Army Topographic Conference, Fort Belvoir, Virginia, 14-16 October 1987. AD-A188 140

Tolson, Michael J. "AirLand Battlefield Environment (ALBE) Tactical Decision Aid (TDA) Demonstration Program." 12th Annual DOD Mapping, Charting and Geodesy Conference, Cameron Station, Alexandria, Virginia, 20-22 October 1987. AD-A188 210

Tolson, Michael J., and Capps, Penny R. "AirLand Battlefield Environment (ALBE) Tactical Decision Aid (TDA) Demonstration Program." Tenth Army Topographic Conference, Fort Belvoir, Virginia, 14-16 October 1987. AD-A188 166

Witzgall, Christoph (National Bureau of Standards). See Mandel, Betty A.

Zimmermann, Bruce B.; Rosenthal, Richard L.; and Breen, Jerry M. "Geographic Information Systems in Robotic Vehicles." Geographic Information Systems (GIS) in Government Workshop, Springfield, Virginia, 10-13 December 1985. AD-A166 859

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Accuracy of Cartometric Data	AD-810 496	1966
Accurate Ephemeris Time Determination and Geocentric Stations Position from Photographs of the Moon Against Stellar Background	ETL-RN-72-4	1972
Acousto-Optic Technology for Topographic Feature Extraction and Image Analysis	ETL-0256	1981
Acquisition and Evaluation of Thermal Standard Data	ETL-0218	1980
Adjunct Development Test II (DT II) of Position and Azimuth Determining System AN/USQ-70	ETL-0217	1980
Advanced Continuous Tone Plate and Process Compatible with Present Military Lithographic Reproduction Equipment and Practices	ETL-0056	1975
Advanced Edit System	ETL-0295	1983
Advanced Feature Symbolization for Three Dimensional Views	ETL-0223	1980
Advanced Methods for the Calibration of Metric Cameras		1968
Advanced Radar Topographic Application	ETL-CR-73-2	1973
Advanced Satellite Hardware/Software System Study	ETL-0225	1980
Advanced Satellite Tracking Instrumentation Study		1968
Advanced Study of a Position and Azimuth Determining System (Final)	AD-844 930L	1968
Advanced Study of a Position and Azimuth Determining System (Addendum)	AD-848 369L	1968
Advanced Study of a Position and Azimuth Determining System (Supplement)	AD-861 446L	1969
Advanced Techniques for the Reduction of Geodetic SECOR Observation (Final)	AD-640 238	1966
Advanced Techniques for the Reduction of Geodetic SECOR Observation (Supplement)	AD-664 744	1967
Aerial Triangulation by Least Squares, Final Report	AD-140 062	1957
AGFA Contour Film	ETL-TR-73-1	1973
Airborne Positioning and Attitude Data Application Study, Phase I	AD-815 525L	1967
Airborne Positioning and Attitude Data Applications Study, Phase II	AD-815 526L	1967
Air Photo Analysis, Photo Interpretation Logic, and Feature Extraction	ETL-0329	1984
Algorithms for Digital Terrain Data Modeling	ETL-0302	1982
All-Weather Mapping Contour Plotting Program		1965
Alternative Theories of Inference in Expert Systems for Image Analysis	ETL-0382	1985
Altimeter, Surveying, 4500 Meters, 2-Meter Divisions	1350-TR	1954
Analog Graphic Processing for 3-D Terrain Displays, Profiles, and Elevation Layer Tints	ETL-0026	1975
Analog to Digital Converter to Digital Magnetic Recorder Interface	ETL-CR-71-4	1971

TITLE	REPORT NO.	YEAR
Analysis and Development of Digital Mapping System Software	ETL-CR-74-5	1974
Analysis and Development of Image Statistics and Redundancy Removal	ETL-0239	1980
Analysis and Simulation of Discrete Digital Image Matching	ETL-0278	1981
Analysis and Tests of Environmental Effects on Gyrocompassing Accuracy	ETL-0378	1984
Analysis of a Relaxation Scheme to Improve Terrain Elevation Data, An	ETL-0298	1982
Analysis of Edge Detection Algorithms on DIAL	ETL-0371	1985
Analysis of GEOS PC-1000 and SECOR Data	AD-882 165L	1967
Analysis of Interactive Image Cleansing Via Raster-Processing Techniques	ETL-0347	1983
Analysis of LANDSAT Systems for Cartographic and Terrain Information (Report No. 9 in the ETL Series on Remote Sensing)	ETL-0103	1977
Analysis of Multispectral Scanner Data for Location of Sand and Gravel Deposits	AD-705 673	1970
Analysis of Radar Calibration Data (Final)	AD-827 858L	1967
Analysis of Radar Calibration Data (Supplement)	AD-836 943L	1968
Analysis of SECOR Data--Vol. I	AD-865 488L	1968
Analysis of SECOR Data--Vol. II	AD-865 489L	1969
Analysis of the Max-Min Texture Measure, An	ETL-0280	1982
Analysis, Storage and Retrieval of Elevation Data with Applications to Improve Penetration	ETL-0179	1979
Analytic Aerotriangulation: Triplets and Sub-Blocks Including Use of Auxiliary Data	AD-631 072	1965
Analytical Aerial Triangulation	1510-TR	1958
Analytical Aerial Triangulation Error Analysis and Application of Compensating Equations to the General Block Triangulation and Adjustment Program (Interim)	AD-271 442	1961
Analytical Aerial Triangulation Error Analysis and Application of Compensating Equations to the General Block Triangulation and Adjustment Program (Final)	AD-401 689	1962
Analytical Aerial Triangulation with Large Computer (Analytical Simultaneous Block Triangulation Technique)	34-TR	1966
Analytical Aerial Triangulation with Small Computer	13-TR	1963
Analytical Aerotriangulation Using Triplets in Strips	AD-668 683	1965
Analytical Photogrammetric Position System (APPS)	ETL-TR-74-2	1973
Analytical Photogrammetric Position System (APPS) to Support the Field Army	ETL-TR-74-4	1974
Apparent Temperature and Emissivity of Natural Surfaces at Microwave Frequencies	AD-872 878L	1970
Appendix III Narrative Report for Geoscience Overlays		1968

TITLE	REPORT NO.	YEAR
Application of a Feature Selection Technique to Samples of High Resolution Synthetic Aperture Radar Imagery	ETL-0330	1983
Application of a Phase Comparison Radiolocation System to Distance and Position Measurement over Mountainous and Desert Terrain		1957
Application of Artificial Intelligence to Radar Image Understanding	ETL-0387	1985
Application of Biorthogonal Filter Functions to Pattern Recognition and Feature Extraction	ETL-0222	1980
Application of Coriolis Force to Geodetic Measurements	AD-477 136	1965
Application of Hierarchical Data Structures to Geographical Information Systems	ETL-0301	1982
Application of Hierarchical Data Structures to Geographical Information Systems (Phase II)	ETL-0337	1983
Application of Hierarchical Data Structures to Geographical Information Systems (Phase III)	ETL-0376	1984
Application of Hierarchical Data Structures to Geographical Information Systems (Phase IV)	ETL-0411	1985
Application of Inertial Techniques to Surveying	AD-805 156	1966
Application of Image Sensing Arrays to Metrology, Detection and Instrumentation	ETL-CR-71-6	1970
Application of Image Sensing Arrays to Metrology, Detection and Instrumentation	ETL-CR-72-5	1972
Application of Image Sensing Arrays to Metrology, Detection and Mapping, Interim	ETL-CR-74-9	1974
Application of LORAC to Precision Terrestrial Line-Length Measurement and Position Fixing	AD-232 015	n.d.
Application of Scalar Renormalization to the Scattering of Electromagnetic Waves from a Three-Dimensionally Inhomogeneous Medium with Strong Dielectric Fluctuations	ETL-0020	1975
Applications of Advanced Accelerometers to Surveying and Geodesy I	AD-429 324L	1963
Applications of Advanced Accelerometers to Surveying and Geodesy II	AD-439 969L	1964
Applying Photogrammetry to Real Time Collection of Digital Image Data	ETL-0275	1981
Approach to the Evaluation of Strategies in Insurgency		1968
APPS-IV Civil Works Data Extraction/Data Base Application Study (Phase I)	ETL-0310	1982
APPS-IV Civil Works Data Extraction/Data Base Application Study (Phase II)	ETL-0336	1983
APPS-IV Remote Sensing Applications Guide	ETL-0333	1983
ARK-1 Gyro Aiming Circle (Wild Heerbrugg Instruments, Inc.)	49-TR	1969
ARMIDOP/ZERO-DOP Positioning Technique	ETL-RN-71-2	1971

TITLE	REPORT NO.	YEAR
Army Terrain Information System	ETL-0050	1976
Artifact Removal in Frequency Domain Compressed Imagery	ETL-0233	1980
Artillery Survey System, Phase 1--Study of Methods		1958
Aspects and Methods of Non isotropic Land Navigation Error Control Including Consideration of Topography	ETL-RN-71-4	1971
Assessment of Inertial Technology for Gravity Survey Applications	ETL-0291-1	1982
Assessment of Means for Determining Deflection of the Vertical	ETL-0303	1982
Associative Array Processing of Raster Scanned Data for Automated Cartography	ETL-0046	1976
Associative Array Processing of Raster Scanned Data for Automated Cartography II (Improved Resolution and Data Handling)	ETL-0132	1977
Associative Array Processing for Topographic Data Reduction	ETL-CR-74-1	1974
Associative Array Processing for Topographic Data Reduction, Final Report	ETL-CR-74-20	1974
Astronomical Attachment Azimuth Determination, Reflecting, for Transit or Theodolite	1374-TR	1954
ATF-Hadego Photocompositor Photolettering Machine	1414-TR	1955
Atmospheric Refraction	TR-61-505	n.d.
Atmospheric Refraction for Satellite Photography	56-8B-1	1962
Automated Processing of Geographic Information in Image Data Forms	ETL-0114	1977
Automated Technique for Measuring Built-Up Urban Areas from Map Graphics through Analog Image Processing	ETL-0012	1975
Automatic Contour Digitizer (ACD)	ETL-ETR-71-2	1971
Automatic Contouring Instrumentation	1488-TR	1957
Automatic Control of Digital Stereo Correlation Methods	ETL-0356	1984
Automatic-electro Optical Satellite Triangulation System	RN-23	1967
Automatic Feature Extraction/Algorithm Testing	ETL-0410	1985
Automatic Feature Extraction: An Annotated Bibliography	ETL-0189	1979
Automatic Map Compilation System	AD-277 456	1962
Automatic Point Marking Measuring and Recording Instrument	AD-610 044	1964
Automatic Point Transfer Instrument	AD-834 230L	1968
Automatic Reseau Measuring Equipment (ARME)	ETL-0099	1976
Automatic Stereo Perception of Aerial Photography by Means of Optical Correlation	AD-406 363	1962
Automatic Type/Symbol-Placement Developments	ETL-TR-74-9	1975
Automation of Airborne Profile Recorder Data Reduction (Interim)	AD-805 562L	1966

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Automation of Airborne Profile Recorder Data Reduction (Final)	AD-825 545L	1967
Autonomous Ground Vehicles: Control System Technology Development	ETL-0375	1984
Background Study and Selection Criteria Analysis of MIL-STD-810C: Environmental Test Methods	ETL-0154	1978
Backscattering of Electromagnetic Waves from a Slightly Rough Surface with a Lossy Layer	ETL-TR-74-10	1974
Backscattering of Electromagnetic Waves from a Surface Composed of Two Types of Surface Roughness	ETL-TR-71-4	1971
Backscattering of Radar Waves by Vegetated Terrain	ETL-0105	1977
Backscattering of Radar Waves from a Tilted, Slightly Rough Surface	ETL-0124	1977
Base Plant Correlator	ETL-CR-71-15	1971
Base Plant Correlator (Final Report)	ETL-CR-73-3	1973
Basic Factors Limiting the Accuracy of Mapping and Aerotriangulation by Photogrammetric Procedures (Final Report)	AD-77 390	1955
Bayesian Approach to Identification of a Remotely Sensed Environment	AD-860 060	1969
Bibliographic Literature Search Concerning the Relationship Between Soils and Plants in Arid and Semi-Arid Regions in North America	ETL-0171	1978
Bibliography and Abstracts of Analytical Photogrammetry	1487-TR	1957
Bibliography of In-House and Contract Reports	ETL-S-70-1	1970
Bibliography of In-House and Contract Reports, Supplement 1	ETL-SR-71-3	1971
Bibliography of In-House and Contract Reports, Supplement 2	ETL-SR-72-3	1972
Bibliography of In-House and Contract Reports, Supplement 3	ETL-0013	1975
Bibliography of In-House and Contract Reports, Supplement 4	ETL-0042	1976
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Bibliography of In-House and Contract Reports, Supplement 9	ETL-0255	1981
Bibliography of In-House and Contract Reports, Supplement 10	ETL-0282	1982

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Bibliography of In-House and Contract Reports, Supplement 11	ETL-0320	1983
Bibliography of In-House and Contract Reports, Supplement 12	ETL-0353	1984
Bibliography of In-House and Contract Reports, Supplement 13	ETL-0395	1985
Bimodal Display	ETL-0110	1977
Blue Laser	ETL-0412	1985
Broad-Spectrum Electromagnetic Spectrum Backscatter	AD-878 341L	1970
Brush Surfaced Lithographic Press Plates	1452-TR	1956
Camera Calibration Study		n.d.
Capabilities of Remote Sensors to Determine Environmental Information for Combat	ETL-0081	1976
Cartographic Application of Conflex I		1964
Cartographic Design Standards--A Preliminary Investigation		1967
Cartographic Drafting Methods and Equipment	1305-TR	1953
Cartographic Drafting Methods and Equipment (Plastic Scribing Process) Second Interim Report	1339-TR	1954
Cartographic Electron Beam Recorder (EBR) System	ETL-0111	1977
Cartographic Electron Beam Scanner Design Study	ETL-0257	1981
Cartographic Scanner Plotter	ETL-CR-72-12	1972
Change Detector Maintenance Instructions		1966
Change Detector Operation Manual		1965
Change Detector Studies		1961
Characterization and Optimization of an Electro-Optic Imaging Device for Real-Time Map Profiling	ETL-CR-74-18	1974
Characterization of the PROM for Coherent Optical Processing Applications	ETL-0053	1976
Charging Equipment, Mobile (CEM)	ETL-0089	1976
Chemical Array Studies	ETL-0130	1977
Circularly Polarized Measurements of Radar Backscatter from Terrain	ETL-0199	1980
Circularly Polarized Measurements of Radar Backscatter from Terrain and Snow Covered Terrain	ETL-0234	1980
Circumpolar Method for Determining Azimuth	ETL-0317	1983
Classification and World Distribution of Vegetation Relative to V/STOL Aircraft Operations	ETL-SR-74-4	1973
Classification of Cartographic Features Through Walsh Transforms	ETL-0290	1982
Classification of Metamorphic Rocks and Their Applications to Air Photo Interpretation Procedures, The	ETL-0341	1983

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Coated Paper and Developer for Continuous Tone Electrophotography	AD-674 241	1968
Cold Weather Testing of 10-Second Direction Theodolite, 1-Minute Direction Theodolite (Foreign Model), Astronomical Attachment, and Winterization Kit	1288-TR	1953
Color Contact Printer Mark III	ETL-ETR-70-9	1970
Color Ink-Jet Demonstration Program	ETL-0196	1979
Color Orthophotomaps	ETL-ETR-72-2	1972
Color Separation System Evaluation	AD-672 078	1968
Combination Map Reproduction Van Body	1536-TR	1958
Combined Engineering and Service Tests of the Copy and Supply Van Section of the Motorized Photomapping Train	1444-TR	1956
Combined Engineering and Service Tests of the Map Revision Van Section of the Motorized Photomapping Train	1447-TR	1956
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Combined Engineering and Service Tests of the Photomapping Van Section of the Motorized Photomapping Train	1428-TR	1955
Combined Engineering and Service Tests of the Rectifier Van Section of the Motorized Photomapping Train	1544-TR	1958
Command Retrieval Information System/Direct Input (CRIS/DI)	42-TR	1968
Comparative Aerotriangulation Tests of the Multiplex Kelsh Plotter, Stereoplanigraph, Wild Autograph Model A-5, and Wild Stereoplotter Model A-6	1349-TR	1954
Comparative Study of Photography for Soils and Terrain Data	38-TR	1968
Comprehensive Summary of Project Trend	ETL-0041	1975
Computer-Assisted Likely Minesite Prediction Model and Estimated Electromagnetic and Thermal Soil Properties	ETL-0391	1985
Computer for Army Artillery Inertial Survey System (GEISHA)	AD-814 052	1963
Computer Program to Simulate Scenario Functions	ETL-0025	1975
Computing a Line-of-Sight Using Digital Image Matching and Analytical Photogrammetry	ETL-0027	1975
Concept Development of Automated Image Analysis	ETL-0194	1979
Concept Development of Automatic Instrumentation for Monitoring Movement of Dams	ETL-0187	1979
Concept for an Ultraprecise Geodetic Baseline	RN-24	1967
CONPLOT I--A Contour Generating Program	ETL-CR-70-2	1970
CONPLOT II--A Contour Generating Program	ETL-CR-71-1	1971
CONRAD--A Program to Contour Radar Data	ETL-CR-73-20	1973

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Continuous-Tone Electrophotography	AD-673 881	1968
Contour Digitizing and Tagging Software (CONTAGRID)	ETL-0228	1980
Contribution to the Philosophy of Climatic Design Limits for Army Materiel: Extreme Hot-Desert Conditions	ETL-TR-72-5	1972
Control Unit for Army Artillery Inertial Survey System (GEISHA)	AD-814 068	1968
Controlled Color for Contact Printing Aerial Imagery	ETL-TR-72-4	1972
Coordinate Measurement Research: Basic and Applied Experiments with the Negative- Reticle Concept	ETL-CR-72-14	1972
Corona Study Relevant to Electrostatic Printing Process	ETL-CR-71-22	1971
Corps of Engineers Maintenance Package for Inertial Survey Equipment	AD-847 498	1963
Correlation of Noisy Images	ETL-0230	1980
Cultural Data Base Implementation Study and Computer-Aided Scene Modeling System Users Manual	ETL-0380	1984
Data Base Sizing Methodology Applied to the Army Terrain Information System (ARTINS)	ETL-0150	1978
Data Integrity Factors Affecting the Construction of the Mapping, Charting, and Geodesy Data Base	ETL-0357	1983
Data Weighting Analysis	AD-672 101	1968
Decision Path Approach to Guidance for Climatic Environmental Test Planning (MIL-STD-810C)	ETL-0183	1979
Defense Mapping Agency (DMA) Raster-to-Vector Analysis	ETL-0383	1984
Defense Mapping Agency (DMA) Raster-to-Vector Analysis--Appendix	ETL-0383A	1984
Defense Mapping Agency (DMA) Raster-to-Vector Benchmark Testing	ETL-0384	1984
Delta Pulse Code Modulation Compression Relative to Stereo Image Matching	ETL-0157	1978
Demonstration and Evaluation of the Utilization of Side-Looking Airborne Radar for Military Terrain Analysis	ETL-0023	1975
Derivation and Potential of New Filter Equations for Numerical Weather Prediction	ETL-RN-71-3	1971
Description of Instrumentation Data Analysis and Reduction for an Atmospheric Seeing Monitor	AD-701 124	1969
Design and Analysis of a High-Production Mini- Computer System for Regridding Digital Terrain Elevation Matrices	ETL-0240	1980
Design and Development of a Position and Azimuth Determining System (PADS)	ETL-CR-71-18	1971

TITLE	REPORT NO.	YEAR
Design and Development of an Advanced Electron Beam Control System	ETL-0032	1975
Design and Development of Power Package for Surveying Instrument: Azimuth, Gyro, Lightweight	ETL-CR-71-5A	1971
Design and Development of Surveying Instrument: Azimuth, Gyro, Lightweight (SIAGL)	ETL-CR-71-5	1971
Design and Fabrication of a 70 Millimeter Interference Imaging System	ETL-CR-71-8	1971
Design and Fabrication of an Experimental Multiband Camera	ETL-CR-71-28	1971
Design and Feasibility Study of an Off-Line Digital Orthoprinter for Field Use	ETL-0149	1978
Design and Feasibility Study of HOC as a Van Mounted Stereo Model Digitizer	ETL-0109	1977
Design, Fabrication, and Test of a Position and Azimuth Determining System (PADS)	ETL-CR-73-6	1973
Design Issues in Video Disc Map Display	ETL-0362	1984
Design, Modification, Fabrication, and Test of a Prototype Miniaturized North Reference Unit (MINRU)	ETL-0276	1979
Design of a Laser Experiment for the Verification of the Inverse Scattering Theory	AD-463 012L	1965
Design of a Map Update Capability for Engineer Topographic Units	ETL-0107	1977
Design of an Experimental Program for Evaluation of LBR Systems	ETL-0182	1979
Design of Engineering Test Model, Topographic Data System		1961
Vol. 1	AD-270 216L	1961
Vol. 2	AD-270 205L	1961
Vol. 3	AD-270 208L	1961
Vol. 4	AD-270 210L	1961
Vol. 5	AD-270 209L	1961
Design Studies and Prototype Model Development of a Small North Orienting Device (Miniaturized Gyrocompass)	ETL-CR-70-4	1970
Design Study of a Large Format Printer (LFP)	ETL-0368	1984
Desk Model Fotosetter Photo-Lettering Machine	1329-TR	1953
Detecting Line-Road and Road-Intersection Patterns at Various Angles	ETL-0274	1981
Determination of Height Differences from Gravity and Gravity Gradients	ETL-71-CR-10	1971
Determination of Level Sensitivity (Field Calibration with the Level on the Instrument)	ETL-RN-74-4	1974
Determination of the Anomalous Gravity Potential from Satellite and Terrestrial Data Under Utilization of Modern Gravimetric Theory	ETL-RN-73-2	1973

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Determination of the Geometrical Quality of Comparators for Image Coordinate Measurements	RN-3	1962
Determinations and Statistical Studies of Gravimetric Deflections	ETL-CR-74-8	1973
Determinations and Statistical Studies of Gravimetric Deflections, Final Report	ETL-0017	1975
Determinations of Direct and Inverse Azimuths, Zenith Distance, Hour Angle, Declination and Distance Between Two Points on Normal Sections	RN-19	1967
Developing a Data Base for Predicting Soviet Tactical Behavior	ETL-0015	1975
Development of a High Precision Capability for Monitoring Structural Movements of Locks and Dams	ETL-0121	1977
Development of a Prototype Family of Military Geographic Intelligence Products to Support Airmobile Operations	ETL-ETR-70-7	1970
Development of a Small North Orienting Device		1970
Development of a Terrain Profile Recorder Image Point Transfer Instrument	AD-649 830	1967
Development of a Variscale Stereo Point Marking Instrument	AD-643 722	1966
Development of an Evaluation Model-Change Detector		1965
Development of an Experimental Family of Military Geographic Intelligence (MGI) Products to Support Battlefield Sensor Activities	ETL-TR-72-3	1972
Development of Descriptor Sets for the Unambiguous Characterization of Geographic Features on SAR Imagery	ETL-0369	1984
Development of Electronic Control of a Superconducting Gravity Gradiometer	ETL-0397	1985
Development of Finite Element Models for the Earth's Gravity Field Phase I: Macro Gravity Model for Satellite Orbit Integration	ETL-0096	1977
Development of Finite Element Models for the Earth's Gravity Field Phase II: Fine Structure Disturbance Gravity Representations	ETL-0097	1977
Development of Height Finder Oblique, Topographic	1383-TR	1954
Development of High Speed CRT Print Head Systems for Cartographic Applications	ETL-0213	1980
Development of Improved Area Correlation Techniques	ETL-CR-73-19	1973
Development of Lightweight Long-Range Survey System (LRSS)	AD-477 042	1965

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Development of Spherical Map Sections and Transparent Conforming Overlays	1440-TR	1956
Development, Service Tests, and Production Model Tests, Autofocusing Rectifier	1307-TR	1953
Development, Test, Preparation, Delivery, and Installation of Algorithms for Optimal Adjustment of Inertial Survey Data	ETL-1307	1982
Developmental Optical Correlator	ETL-0033	1975
Digest of High Temperature Storage Literature	ETL-0152	1978
Digital Automatic Map Compilation System	AD-285 258	1962
Digital Cartographic Study and Benchmark	ETL-0168	1978
Digital Cartographic Study and Benchmark-- First Interim Technical Report	ETL-0090	1975
Digital Cartographic Study and Benchmark-- Second Interim Technical Report	ETL-0091	1975
Digital Cartographic Study and Benchmark-- Third Interim Technical Report	ETL-0092	1976
Digital Cartographic Study and Benchmark-- Fourth Interim Technical Report	ETL-0093	1977
Digital Computer Program for the Solution of a Photogrammetric Net (Preparation of Maps from Aerial Photographs)	AD-711 858	1961
Digital Data Editing System	ETL-0146	1977
Digital Data to Pressplate Study	ETL-0044	1976
Digital Image Manipulation and Enhancement System (DIMES) User's Handbook	ETL-CR-73-7	1973
Digital Laser Platemaker Modifications	ETL-0379	1984
Digital Map Color Proofing Methodologies Evaluation, Final Report	ETL-0372	1984
Digital Map Color Proofing Methodologies Evaluation, Final Report (Proprietary)	ETL-0373	1984
Digital Mapping Glossary	AD-A782 328	1974
Digital Mapping System Concepts Study	ETL-CR-71-26	1971
Digital Mapping System: Mathematical Processing	ETL-CR-74-6	1974
Digital Mapping System Study	ETL-CR-71-25	1971
Digital Planimetric Compiler	ETL-ETR-72-1	1972
Digital Pre-Press System Design Study	ETL-0339	1983
Digital Radar Restitution	AD-448 230L	1964
Digital Rectification of Side-Looking Radar (DRESLR)	ETL-CR-73-18	1973
Digital Simulation of a Radar Image of Pisgah Crater Test Site, California	ETL-0019	1975
Digital Terrain Data Compaction Using Array Algebra	ETL-0108	1976
Digital Terrain Elevation Model Analysis	ETL-0393	1985
Dimensionally Stable Opaque Cartographic Bases	1469-TR	1956
Direct Digital Color Proofing Technology Overview	ETL-0351	1984
Direct Electronic Transforms for Feature Extraction	ETL-0139	1978

TITLE	REPORT NO.	YEAR
Discrete Scattering Approach to Vegetation Modeling	ETL-0215	1980
Discrimination of Tropical Land Use in Puerto Rico: An Analysis Using Multispectral Imagery	ETL-CR-71-20	1971
Discrimination of Water from Shadow Regions on Radar Imagery Using Computer Vision Techniques	ETL-0404	1985
Display Technologies for Topographic Applications. Assessment of State-of-the-Art and Forecast	ETL-0016	1975
Distribution of Mean Monthly Precipitation and Rainfall Intensities	ETL-SR-72-5	1972
Diurnal Freeze-Thaw Frequencies in Selected Regions of the High Latitudes	ETL-0364	1984
Doppler Satellite for Army Field Operations	AD-470 472	1965
Doppler Translocation Test Program	41-TR	1968
Doppler Translocation Test Program	ETL-ETR-74-5	1974
Earth's Gravitational Field from Observation of Near-Earth Satellites and Terrestrial Gravity Measurements	RN-30	1968
EBR Extension of Graphics Generator to Include Symbols	ETL-CR-74-12	1974
Effects of Soil Moisture and Vegetation on Surface Temperature, The	ETL-0324	1983
Effects of Supersonic and Hypersonic Aircraft Speed upon Aerial Photography	AD-226 577	1959
Effects of Supersonic and Hypersonic Aircraft Speed upon Aerial Photography	AD-248 726	1960
Effects of Supersonic and Hypersonic Aircraft Speed upon Aerial Photography, Final Report		1960
Effects of the Atmosphere on Aerial Photography	TN-70-1	1970
Electrofax Specifications for Army Five-Color Map Reproducing Equipment	AD-841 828L	1968
Electron Beam Recorder Applications Study	ETL-0120	1970
Electronic Angle-Measuring Device	ETL-TR-72-1	1972
Electronic Feedback Control of Mass-Spring Systems	ETL-0398	1985
Electronic Pointing Device (Microwave) System (Electrotransit)	AD-471 726L	1965
Electronic Survey Equipment and Tests	AD-264 454	1960
Electro-Optical Image Processing with an Image Storage Tube	AD-A836 685	1968
Electrophotographic Imaging Materials Evaluation	ETL-0266	1981
Electrostatic Paper and Toner Development		1969
Elevation Data Compaction by Polynomial Modeling	ETL-0140	1978
Elevation Data Edit Terminal	ETL-0328	1983
Emergency Target Location Function	21-TR	1965
Engineer Design Test and Evaluation of a Planimetric Compiler	35-TR	1966
Engineer Design Tests and Evaluation of a Multipower Army Stereoscope	12-TR	1963

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Engineer Route Reconnaissance Feasibility Study	AD-486 337L	1966
Engineer Test and Evaluation of the Command-Retrieval Information System/Direct Input (CRIS/DI)	42-TR	1968
Engineer Tests of 2.5x Reduction Printer	ETL-ETR-74-7	1975
Engineering Design Test Report: Inertial Surveying Equipment (ISE)	16-TR	1963
Engineering Evaluation of Pulsed Xenon Light Sources for Graphic Arts Use	2-TR	1961
Engineering Test Report: Elevation Meter, Ground	5-TR	1962
Engineering Test Report: Lightweight Gyro Azimuth Theodolite (Lear North-Seeking Gyro Model No. 11NG530A)	11-TR	1963
Engineering Test Report of the Integrated Mapping System	7-TR	1962
Engineering Test Report Short Range Electronic Positioning Equipment (SREPE)	9-TR	1963
Engineering Tests and Evaluation of a 9 by 18 inch Electronic Printer	1646-TR	1960
Engineering Tests and Evaluation of Multiplex Reduction Printer for Metrogon and Distortion-Free Photography	1431-TR	1955
Engineering Tests and Evaluation of Printers for the Preparation of 9½- by 9½-inch Diapositives for the Precision Stereoplotter	1538-TR	1958
Engineering Tests and Evaluation of the Photogrammetric Transforming Printer for 20° Convergent Photograph	1497-TR	1957
Engineering Tests of a Temperature-controlled Processing Unit, Deep-tank, for Photomechanical Film	1599-TR	1959
Engineering Tests of Diapositive Processing Unit	1628-TR	1960
Engineering Tests of Interim Target Location Systems for Use in Controlled Areas	1498-TR	1957
Engineering Tests of Interim Target Location Systems for Use in Uncontrolled Areas	1612-TR	1960
Engineering Tests of Opaque Cartographic Bases	1290-TR	1953
Engineering Tests of Scanning Stereoscope	1491-TR	1957
Engineering Tests of the Cartographic Grid Ruler	1486-TR	1957
Engineering Tests of the Cartographic Van Section of the Motorized Photomapping Train	1373-TR	1954
Engineering Tests of the PPI Radar Presentation Restitutor	1629-TR	1960
Engineering Tests of Translucent Cartographic Bases	1461-TR	1956
Engineering Tests of Two Printer-Developers, Ammonia Process, 24 Inch	1292-TR	1953
Enhanced Photomap Evaluation Study	AD-651 396	1967
Enlarging Printer, 3x	ETL-0049	1976

TITLE	REPORT NO.	YEAR
Environmental Conditions Experienced by Rockets and Missiles in Storage, Transit, and Operations	ETL-CR-74-3	1973
Environmental Conditions Experienced by Rockets and Missiles in Storage, Transit, and Operations, Supplement	ETL-CR-74-3-S	1973
Environmental Conditions in a Tropical Forest Region in Thailand	ETL-0129	1974
Environmental Position Errors of the GPS-- Army User Equipment	ETL-0055	1976
Equilibrium Figures and the Normal-spheroid of the Earth Mass-Functions and Isostasy		1968
Equipment and Techniques for the Utilization of Convergent Photography in Mapping	1583-TR	1959
Error-Free Compression of Digital Imagery	ETL-0079	1976
Error Propagation into Orbital Positions	ETL-CR-73-13	1973
Error Propagation in Two-Photo Intersection	ETL-RN-72-1	1972
Error Statistics for Astrogeodetic Positions for an RGSS Test Course	ETL-0267	1981
Errors in Automatic Pass Point Mensuration Using Digital Techniques	ETL-0232	1980
Establishment of an Ideal World Geodetic System	AD-680 225	1968
ETL 211-OD Gravitational Model, A Union Solution of Optical and Doppler Satellite Determinations	AD-502 044L	1968
Evaluating Soil Moisture and Textural Relationships Using Regression Analysis	ETL-0226	1980
Evaluation and Comparison of Terrain Classification Methods (Type III)	AD-845 338L	1968
Evaluation and Test of a Five-Color Electrostatic Printing Machine for the Reproduction of Topographic Maps and Charts	25-TR	1965
Evaluation and Test of a Modified Plate Process Section, a Proposed New Photomechanical Process and a Redesigned Brush-Surfacing Machine	1560-TR	1959
Evaluation and Test of a Self-Contained Vehicle Land Navigation System	ETL-0167	1979
Evaluation and Test of a Single-Color Electrostatic Printing Machine for the Reproduction of Topographic Maps and Charts	19-TR	1964
Evaluation of a New Electrostatic Recording Medium	ETL-0102	1977
Evaluation of a Xerographic Process for Preparing Zinc Oxide-Silicone, Binder-Type Lithographic Plates	1545-TR	1958
Evaluation of Automatic Mapping APQ as a Radar Mapping System	31-TR	1966
Evaluation of Coherent Radar Photography	18-TR	1963

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Evaluation of Color Recognition Devices for Making Color-Separations from Multicolor Maps and Charts	1401-TR	1955
Evaluation of Color Test Photography for Military Geographic Analysis: A Literature Review	ETL-TR-70-6	1970
Evaluation of Components for Some Elevation-Determining Systems	AD-407 297L	1963
Evaluation of Conventional Correlation Methods When Matching Infrared Imagery to Panchromatic Imagery	ETL-0195	1979
Evaluation of Experimental Xerographic Process for Lithographic Platemaking	1417-TR	1955
Evaluation of High Precision SHORAN-Controlled Photography	1484-TR	1957
Evaluation of Land Use Techniques for Processing MGI	AD-817 124L	1967
Evaluation of Multiband and Color Aerial Photography for Selected Military Geographic Intelligence in a Subtropical Desert Environment	54-TR	1970
Evaluation of Offset Collotype Printing for the Field Reproduction of Aerial Photographs	1465-TR	1956
Evaluation of Pointing to a Sharp Edge	AD-668 260	1968
Evaluation of Published Criteria for Identifying Metamorphic Rocks on Air Photos: Two Case Studies in the Northeastern United States	ETL-0326	1983
Evaluation of Registering Image Gradients When Matching Infrared Imagery to Panchromatic Imagery	ETL-0250	1981
Evaluation of Single and Multicolor Map and Chart Reproduction Equipment	ETL-0080	1976
Evaluation of the Method of Determining Parallax from Measured Phase Difference	ETL-0145	1977
Evaluation of the Prototype, Natural-Image Computer	48-TR	1969
Evaluation of the Stellar-Moon Camera System	AD-673270	1968
Evaluation Tests of Royal Zenith, 29 Press	1490-TR	1957
Evidential Reasoning in Expert Systems for Image Analysis	ETL-0381	1985
Experimental Assessment of Improved Spatial Resolution LANDSAT Data	ETL-0268	1981
Experimental Correlator Studies	AD-374 450L	1966
Experimental Determinations of Fringe Counting Errors Associated with Rotation of a Corner Cube Forming an Arm of a Laser Interferometer	RN-26	1967
Experimental Heterodyne Optical Correlator	ETL-0071	1976
Experimental Production of Military Geographic Intelligence Products from Side-Looking Airborne Radar Imagery	AD-376 554	1966
Extended Area Exit Pupil Viewer	ETL-0399	1985

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Extension of Kendall's Concordance Test Where Ties are Allowed, An	ETL-0316	1983
Extraction of Mapping Detail from Radar Photography	AD-328 256	1961
Extraction of Mapping Detail from Radar Photography	AD-328 257	1961
Extreme 24-Hour Snowfalls in the United States: Accumulation, Distribution, and Frequency	ETL-SR-73-4	1973
Feasibility of Using Optical Power Spectrum Analysis Techniques for Automatic Feature Classification from High Resolution Thermal, Radar, and Panchromatic Imagery	ETL-0186	1979
Feasibility Study for an All-Weather Surveying Signal Light	37-TR	1968
Feasibility Study for Field Generation of Input for Radar Scene Generation from DLMS Terrain and Elevation Data	ETL-0203	1978
Feasibility Study of a Quick Response Multicolor Printer (QRMP)	ETL-0242	1980
Feasibility Test of a Proposed 3-D Radar System	AD-349 882L	1964
Feasibility Test Program for Measurement of Gravity Anomaly Changes Using 2 MICRO-g Accelerometer in the Inertial Platform	ETL-CR-74-16	1974
Feature Analysis and Reduction of Laws Texture Measure	ETL-0343	1983
Feature Component Reduction Through Divergence Analysis	ETL-0305	1982
Feature Extraction Assessment Study, Final Report	ETL-0377	1984
Feature Extraction of the Illiac IV	ETL-0191	1979
Feature Tagging	ETL-0227	1980
FEED Evaluation	ETL-0322	1983
FEED Software Documentation	ETL-0335	1983
Fictitious Data Generator for Analytical Aerotriangulation	AD-640 799	1965
Field Artillery Plotting Equipment	1421-TR	1955
Final Report, Development of Mirror Stereoscope	1382-TR	1954
Final Report on Stable Cartographic Bases	1542-TR	1958
Final Report, Study of Digital Matching of Dissimilar Images	ETL-0244	1980
Finite Element Models of the Earth's Gravity Field Phase IV	ETL-0198	1979
Five-Color Separation Investigation	AD-662 725	1967
Fixed and Multiple Frequency Angle Measurements with 35-GHz Microwaves	33-TR	1966
Floodplain Tree Species: A Bibliographic Literature Search with Abstracts	ETL-0193	1979
Flux Valve Heading Reference System	ETL-0134	1977
Forced Dynamics of Asymmetric Spacecraft	ETL-0039	1976

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Forecast for the 1970's in Mapping, Charting, and Geodesy Research and Development	TN-70-2	1970
Formulas for Computing Atmospheric Refraction for Objects Inside or Outside the Atmosphere	RN-8	1963
Formulation of a Space Oblique Mercator Map Projection	ETL-0131	1977
Fort Belvoir Text Placement System, Final Technical Report	ETL-0199	1979
Fourier Transform Autocorrelation	ETL-0184	1979
Frequency Dependence of Backscatter from Rough Surfaces (An Experiment with Broad-Spectrum Acoustic Waves)	AD-847 275	1968
Full View Holograms	ETL-CR-70-1	1970
Further Investigation of an Electronic Angle- Measuring Device	ETL-TR-74-1	1973
Further Study of Digital Matching of Dissimilar Images	ETL-0385	1985
Gamma-Ray Spectrometer Study	ETL-0008	1975
General Climatological Guide to Daily Freezing Conditions: Frost Days, Ice Days, and Freeze-Thaw Days, A	ETL-0287	1982
General Noniterative Solution of the Inverse and Direct Geodetic Problems	RN-11	1963
General Programming on a Parallel Processor	ETL-0062	1976
Geocentric Position and/or Orbital Parameters with Star Satellite Photography from a Single Camera Station	CR-102-1	1963
Geodetic Control by Means of Astronomic and Torsion Balance Observations and the Gravimetric Reduction of Levelling	AD-672 491	1967
Geodetic Control without Triangulation, Trilateration, or Gravity Data and Gravimetric Reduction of Levelling		
1st Interim Report	AD-447 994L	1964
2nd Interim Report	AD-461 100L	1965
3rd Interim Report	AD-477 474	1965
Geodetic SECOR		1962
Geodetic SECOR Ground Equipment		1964
Geodetic SECOR Satellite	ETL-TR-74-6	1974
Geodetic SECOR Wide-Band RF Subsystem		1967
Geodetic SECOR Wide-Band RF Subsystem for SECOR Ground Equipment Sets	AD-804 780L	1967
Geodetic SECOR Wide-Band System		1966
Geodetic Spacecraft		1961
Geodimeter, Models I and II	1495-TR	1957
Geographic Modelling of Insurgency Resources	AD-848 723L	1969
Geographic Modelling of Insurgency Resources, Appendix	AD-851 896L	1969

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Geoid Representation from Satellite-Determined Coefficients	AD-634 541	1966
Geologic Evaluation of Radar Imagery from Darien Province, Panama	AD-853 884	1969
Geometric Simultaneous Multistation Determination, with Constraints, Using Data from Geodetic Satellites	RN-22	1967
Geometrical Quality of Lunar Mapping by Photogrammetric Methods	RN-9	1962
Geomorphic Evaluation of Radar Imagery of Southeastern Panama and Northwestern Columbia	ETL-CR-71-2	1971
Geopotential Determination from Satellite to Satellite Tracking and Satellite Altimetry	ETL-CR-74-21	1975
Geopotential Determination from Satellite to Satellite Tracking and Satellite Altimetry, Supplement I	ETL-CR-74-21-S	1975
GEOPS	RN-25	1967
Geoscience Potentials of Side-Looking Radar, Vol. I	AD-650 498	1965
Geoscience Potentials of Side-Looking Radar, Vol. II	AD-650 499	1965
Geo-Spin Precision Inertial Survey	ETL-0135	1978
Gigas-Zeiss Digital Control Unit	ETL-ETR-73-1	1973
Gradiometer-Aided Rapid Gravity Survey System	ETL-0112	1977
Graphic Arts Symbol Generating Hardware for a Gerber Plotting System	ETL-CR-74-14	1974
Graphic Data Handling Techniques	AD-659 807	1967
Gravimetric Geodesy Free of Density Estimates through Analysis of Discrete Gravity Data	RN-12	1963
Gravity Anomalies as Indicators of Groundwater Reserves in Glacial Deposits	ETL-CR-73-16	1973
Gravity Correlation Studies for Determination of the Gravity Field of the Earth	AD-866 798L	1970
Gravity Study Program, Final Report	ETL-0262	1981
Gravity Study Program, Interim Report	ETL-0253	1981
Hail and Its Distribution	ETL-SR-73-3	1973
Hexagonal Data Base Study	ETL-0338	1983
Hexagonal Data Base Study, Phase II	ETL-0360	1984
High Resolution Optical Power Spectrum Analyzer	ETL-0127	1978
High Resolution Orthophoto Output Table (HIROOT)	AD-856 731L	1969
High Resolution Orthophoto Output Table	ETL-ETR-72-3	1972
High Speed Disc Memory and a Color Image Display for a Small Computer	AD-878 975L	1970
High-Speed, Large-Format Film Writer Methodologies and Design Study	ETL-0389	1985
High Speed Parallel Sensing Scheme	ETL-0119	1977
History of U.S. Army Engineer Topographic Laboratories (1920 to 1970)	ETL-SR-74-1	1973

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Holographic Compensation of Wavefront Aberrations	ETL-RN-74-11	1975
Holographic Optical Elements With Low Q-Factors	ETL-0123	1977
Holographic Ray Tracing and Spot Diagrams	ETL-0052	1975
Holographic Stereogram Display Techniques for the Viewing and Mensuration of Stereo Photogrammetric Imagery	ETL-CR-74-2	1973
Holographic Terrain Displays	ETL-0083	1976
Holography and Stereoscopy	ETL-CR-72-2	1972
Horizontal Gradients of Gravity in Geodesy	AD-672 492	1964
Horizontal Gradients of Gravity in S.W. Ohio	AD-672 489	1967
Hot Weather Testing of 10-Second Direction Theodolite with Universal Tribrach and Universal Tripod, Astronomical Attachment, Universal Sun Compass, Lensatic Compass, and Wrist Compass Air Photo Patterns	1289-TR	1953
Image Alignment and Correlation System	ETL-0237	1980
Image-Based Approach to Mapping, Charting, and Geodesy	ETL-0366	1982
Image Correlation on a Parallel Processor	ETL-0061	1976
Image Enhancement by Chemical Intensification	ETL-0014	1975
Image Processing for Visual Navigation of Roadways	ETL-0406	1985
Image-Processing Precision and Affecting Relative Orientation	ETL-RN-71-6	1971
Image Scanner Technology Study	ETL-0137	1978
Image Tube Validation Study	ETL-CR-70-5	1970
Implications of Symbol Usage on U.S. Army Maps for an Automated Cartographic System	AD-667 979	1968
Implications of Symbol Usage on U.S. Army Maps for an Automated Cartographic System, Appendix	AD-667 986	1968
Improvement Program Automatic Map Compilation System	AD-442 522	1964
Inertial Platform Subsystem for Army Artillery Inertial Survey System (GEISHA)	AD-681 931	1962
Inertial Positioning System Test Data Summary Report	ETL-0028	1975
Inertial Survey Applications to Civil Works	ETL-0309	1983
Inertial Survey Equipment (GEISHA)	AD-814 051	1963
Inferential Techniques for Soil Depth Determinations, Part I: <i>Coleogyne</i> <i>ramossissima</i> Torr. (Black-Brush)	ETL-0036	1975
Inferential Techniques for Soil Depth Determinations, Part II: <i>Artemisia</i> <i>filifolia</i> Torr. (Sand Sagebrush)	ETL-0176	1979
Influence of Atmospheric Refraction on Directions Measured to and from a Satellite	RN-10	1963

TITLE	REPORT NO.	YEAR
Instrument for Measuring Absolute Acceleration of Gravity	RN-17	1966
Instrument to Measure the Tilt of Large Structures, An	ETL-0313	1983
Instrumentation for Color Aerial Photography	ETL-RN-70-1	1970
Intelligent Advisors for Cross-Country Route Planning	ETL-0365	1984
Interactive Digital Correlation Techniques for Automatic Compilation of Elevation Data	ETL-0272	1981
Interactive Digital Image Processing for Terrain Data Extraction	ETL-0241	1980
Interactive Digital Image Processing for Terrain Data Extraction, Phase 2	ETL-0277	1981
Interactive Digital Image Processing for Terrain Data Extraction, Phase 3	ETL-0294	1982
Interactive Digital Image Processing for Terrain Data Extraction, Phase 4	ETL-0348	1983
Interactive Digital Image Processing for Terrain Data Extraction, Phase 5	ETL-0374	1984
Interactive Digital Image Processing Investigation	ETL-0172	1978
Interactive Digital Image Processing Investigation, Phase II	ETL-0221	1980
Interactive Image Analysis System Design	ETL-0312	1982
Interactive Knowledge-Based Cartographic Feature Extraction	ETL-0273	1981
Interagency Energy and Environmental Survey		1977
Interferometer Data Reduction Study	AD-503 143L	1969
Interim Solution Rectifier Van	1355-TR	1954
Interim Technical Progress Report, Ninth SemiAnnual Technical Report, Sep 1971-Mar 1972, Project THEMIS, A Center for Remote Sensing	ETL-CR-72-4	1972
Interpolation of Deflections from Horizontal Gravity Gradients	AD-672 490	1967
Interpolation of Gravity Anomalies and Deflection of the Vertical Components from Rapid Gravity Survey System Data	ETL-0075	1976
Interpretation of Radar Imagery for Terrain Analysis in Tropical Environments		1968
Inverse Scattering Applications in Determining Terrain Feature Parameters	ETL-0279	1981
Investigation and Evaluation of Planigon Lens Distortion Characteristics	1472-TR	1957
Investigation, Experiments, and Study of Electron Beam Recorder (EBR) Techniques for Map Production	ETL-CR-73-15	1973
Investigation of Bjerhammar's New Gravity Reduction Method	AD-460 404	1964
Investigation of Cartographic Pressplate Recording from Digital Data	ETL-0043	1976

TITLE	REPORT NO.	YEAR
Investigation of Continuous Photoconductive Layer Arrays	ETL-0011	1975
Investigation of Discrete Function Technology for Topographic Sciences	ETL-0162	1978
Investigation of Electro-Acoustic Technology for Topographic Application	ETL-0160	1978
Investigation of Extrema in Digital Images for Texture Analysis	ETL-0210	1979
Investigation of Fusion and Fixation Disparity Limits for Photogrammetry	AD-625 217	1965
Investigation of Linear Transformations for Automatic Cartographic Analysis	ETL-0181	1979
Investigation of Multiband Photographic Techniques, Vol. I	AD-479 300L	1965
Investigation of Multiband Photographic Techniques, Vol. III		1965
Investigation of Photographic Mapping Detail and Data Encoding	AD-286 715	1962
Investigation of Techniques to Generate Contours from Stereo Pairs	ETL-0029	1975
Investigation of the Application of "Array Algebra" to Terrain Modeling	ETL-0141	1978
Investigation of the Electronic Distance Measuring Equipment Electrotape	AD-460 401L	1964
Investigation of the Geometrical Quality of the Relative and Absolute Orientation Procedures and the Final Results of the Photogrammetric Procedure	RN-6	1962
Investigations into the Problems of Relative Orientation in Stereo Aerial Photogrammetry	AD-452 686L	1964
Investigations of Basic Geometric Quality of Aerial Photographs and Some Related Problems	RN-4	1962
Investigations of the Use of Conventional Films in the ETL Cartographic EBR	ETL-0177	1979
Investigations Related to the Establishment of a World Geodetic System	AD-697 163	1969
Joint Analyses in Glen Canyon National Recreational Area	ETL-0073	1976
Kalman Filtering and Smoothing in Fotonap for Orbit Determination using GPS Measurements	ETL-0162	1978
KANDIDATS	ETL-CR-71-3	1971
Knowledge-Based Images Analysis	ETL-0258	1981
KT2 Gyro-Theodolite (Otto Fennel GMBH & Co)	57-TR	1970
Land Cover Classification from LANDSAT Data: Phase III of a Joint OCE/NASA Demonstration	ETL-0175	1979
LANDSAT and DMA Elevation Study	ETL-0386	1984

TITLE	REPORT NO.	YEAR
LANDSAT D: Corps of Engineers Interface with Advanced NASA Ground Systems Study	ETL-0151	1978
Light, Target for Ranging Pole	1402-TR	1955
Lightweight North-Seeking Gyro Azimuth Surveying Instrument, Model 11NG531A	AD-486 317	1965
Lightweight North-Seeking Gyro Azimuth Surveying Instrument, Model 11NG531B	AD-844 011L	1968
Linear Feature Extraction from Radar Imagery	ETL-0405	1985
L.N.K. Software Systems for Transferring, Merging, and Displaying DFAD/DTED Data on AMS/CAPIR	ETL-0318	1983
Long Range Survey System	AD-356 441L	1964
Long Range Surveying System	AD-328 203	1960
Low Cost Gyrocompass	ETL-0355	1984
Low Light Level Photography	32-TR	1966
Manual and Automated Line Generalization and Feature Displacement	ETL-0359	1984
Manual for Maintenance and Operation of the MB-1 Multiband Aerial Camera	ETL-0040	1976
Map Coating Concept Studies	AD-679 215	1968
Map Illuminator Test, Phase I	ETL-0034	1975
MAPCON Design Study	AD-854 619L	1967
Mapping Camera Image Errors Due to Star Camera Identification and Measuring Errors	ETL-RN-73-1	1973
Mapping for Airborne Radar Scope Presentations		1958
Mapping from Radar Presentations, Second Interim Report	1397-TR	1955
Mapping from Side-Looking Radar	AD-392 041L	1968
Mapping with Minimum Ground Control	1483-TR	1957
MAT Transponder Model No. 10002		1967
Materials Research for Holographic Recording (Report No. 1, Multiple Image Storage of Continuous Tone Data in Volume Holograms)	ETL-0088	1976
Materials Research for Holographic Recording (Report No. 2, Bleaching Methods for Photographically Recorded Holograms)	ETL-0156	1978
Materials Research for Holographic Recording (Report No. 3, Hardened Gelatin Holographic Recording Materials)	ETL-0197	1979
Mathematical Analysis of a Technique for the Calibration of a Synthetic Aperture Radar	43-TR	1968
Mathematical Method for Inversion in Atmospheric Remote Sensing, A	ETL-0346	1983
Mathematical Techniques for Automated Cartography	ETL-CR-73-4	1973
Mathematics of Geodetic SECOR Data Processing		1964
Matrix Evaluation of Remote Sensor Capabilities for Military Geographic Information (MGI)	ETL-TR-72-6	1972
MATS Performance with the SECOR System		n.d.
MATS Transponder		1966

TITLE	REPORT NO.	YEAR
Measurement of the Change in the Deflection of of the Vertical with a Schuler-Tuned North- Slaved Inertial System	ETL-0138	1977
Measurement Techniques of Electrical Parameters of Surface Materials in the X-Band Region	ETL-0304	1982
Mechanization Design, Performance Simulations, and Cost Trade-Offs Hybrid INS/GPS/PLRS Positioning and Orientation Systems	ETL-0409	1985
Mensuration and Reduction Accuracy and Precision Standard Applicable to an Integrated World- Wide Topographic System	58-TR	1970
Methodological Preliminaries to the Development of an Expert System for Aerial Photo Interpretation	ETL-0342	1984
Methodology for Military Geographic Analysis	36-TR	1967
Methods and Results of Remote Barometric Altimetry and Views on the Estimation of Meteorological Field Variables	ETL-RN-73-3	1973
Methods for Calculating Atmospheric Refraction and Its Perturbation	ETL-0299	1982
Micromap Camera for Display Systems	ETL-ETR-71-5	1971
Microreduction and Enlargement of Graphic Information Study (MEGIS)	ETL-0063	1977
Microwave Pointing Variations and Angle Measurements	26-TR	1966
Military Applications of Multiband Aerial Photography (Report No. 5 in the ETL Series on Remote Sensing)	ETL-0030	1975
Military Geographic Intelligence Products Associated with the SLAR Topo Map Test in Panama	ETL-ETR-70-10	1970
Military Potential Test of Selected Items of Hydrologic Survey Equipment	AD-890 746	1971
Military Significance of the USAETL Research Note "A New Solution for the Anomalous Gravity Potential Resulting from a Modification of Molodensky's Linear Approximation, Its Practical Significance, and Numerous Ramifications"	RN-34	1970
Miniaturized Gyrocompass	ETL-0289	1982
Miniaturized Gyrocompass (Small North-Orienting Device)	ETL-ETR-70-11	1970
Minipim-MK II Precision Indicator of the Meridian (British Aircraft Corp.)	45-TR	1969
Mini Raster-to-Vector Conversion	ETL-0269	1981
Mod II Power Supply for Army Artillery Inertial Survey System (GEISHA)	AD-814 067	1963
Modeling and Contouring Irregular Surfaces Subject to Constraints	ETL-CR-74-19	1975
Modes of Satellite Triangulation Adjustment, Vol. I	AD-633 863	1966

TITLE	REPORT NO.	YEAR
Modes of Satellite Triangulation Adjustment, Vol. II	AD-633 864	1966
Modification of a Cartographic Mapping Camera from Type T-11 to Type KC-4B (with Automatic Exposure Control)	ETL-TR-71-1	1971
Modification of the MUSAT Aerotriangulation Programs to Accommodate Bathymetric Image Points	ETL-0306	1983
Modifications to FOTONAP	ETL-0116	1977
Mono Versus Stereo Analytical Photogrammetry, Part 1	AD-664 184	1967
Mono Versus Stereo Analytical Photogrammetry, Part 2	AD-828 750	1968
Morphometry of Landforms: Quantification of Slope Gradients in Glaciated Terrain	ETL-RN-72-3	1972
Multi-Altitude Transponder		1967
Multi-Image Correlation Systems Study for MGI	AD-841 079	1968
Multi-Image Correlation Systems Study, Quantitative Evaluation of Electronic Multi-Image Processor		1969
Multi-Image Pattern Recognition: Ideas and Results	AD-863 596	
Multiparametric Figures of Equilibrium: Curvature of the Plumb Line	AD-603 073	1964
Multiparametric Theory of Spheroidal Equilibrium Figures and the Normal Spheroids of Earth and Moon		1966
Multiple Camera Analytical Triangulation Program		1965
Multiple Station Analytical Triangulation Program	AD-638 750	1965
Multipower Army Stereoscope	12-TR	
Multisensor Approaches for Determining Deflections of the Vertical	ETL-0314	1983
Multisensor Study of Plant Communities at Horsefly Mountain, Oregon	AD-698 098	1969
Multisource Image Analysis	ETL-0208	1979
Multispectral Capability of H&W Film (Photographic Technology Series)	ETL-0101	1977
Multispectral Target Signatures	ETL-0165	1978
MUSAT IV	ETL-CR-70-6	1970
Natural Image Computers, Vol. I	AD-856 137L	1967
Natural Image Computers, Vol. II	AD-856 138L	1967
Near-Real-Time Application of Digital Terrain Data in a Minicomputer Environment	ETL-0142	1978
Near-Surface Bathymetry System (Report No. 11 in the ETL Series on Remote Sensing)	ETL-0163	1978
New Analyses and Methods Leading to Improved Target Acquisition Requirements Involving Systems, Geodetic and Reentry Errors, and Increased Weapons Effectiveness for Conventional Weapons (Part I)	RN-35	1970

TITLE	REPORT NO.	YEAR
New Analyses and Methods Leading to Improved Target Acquisition Requirements Involving Systems, Geodetic and Reentry Errors, and Increased Weapons Effectiveness for Conventional Weapons (Part II)	ETL-RN-70-3	1970
New Analytical Methods for Simulation/ Estimation of Asymmetric Satellite Dynamics	ETL-CR-73-21	1973
New Formulas Useful When Changing Ellipsoidal Parameters or Orientation	RN-2	1962
New Insights and Results Regarding L.F. Richardson's Turbulence Criterion	ETL-RN-72-2	1972
New Large-Scale, High-Resolution, Multicolor Software Display Concept, A	ETL-0388	1985
New Method for Determining Azimuth and Latitude Independent of Time and Zenith Distance	RN-17	1966
New Solution for the Anomalous Gravity Potential Resulting from a Modification of Molodensky's Linear Approximation, Its Practical Significance and Numerous Ramifications, A	RN-33	1970
Noise Removal on Radar Imagery Using Local Gradient and Statistics	ETL-0402	1985
Noncontact Array Velocimeter	ETL-0077	1976
North-Seeking Gyrocompass, Final Technical Report	ETL-0251	1980
Occurrence of Ice in the Form of Glaze, Rime, and Hoar-Frost with Respect to the Operation and Storage of V/STOL Aircraft	ETL-SR-73-1	1973
On the Energy Integral for Satellites	RN-29	1968
On the Thermal Nature and Sensing of Snow-Covered Arctic Terrain	ETL-RN-73-4	1973
Optical-Electronic Precision Pointing System		1965
Optical Power Spectral Analysis for Machine-Readable Factor Maps	ETL-0212	1980
Optical Power Spectrum Analysis (OPSA) (Report No. 1 Recording Optical Spectrum Analyzer System Hardware)	ETL-TR-74-11	1975
Optical Theodolite Readout	AD-821 660L	1967
Optimized Digital Automatic Map Compilation System		
1st Interim Report	AD-412 798	1963
2nd Interim Report	AD-422 227	1963
3rd Interim Report	AD-432 243	1963
4th Interim Report	AD-600 117	1964
Optimized Method for the Derivation of the Deflection of the Vertical from RGSS Data	ETL-0122	1977
Optimized Post-Mission Determination of the Deflection of the Vertical Using RGSS Data	ETL-0164	1978
Orthographic Radar Restitutor Engineer Design Test	ETL-ETR-74-6	1974
Orthophoto Viewer and Transfer Device		1965

TITLE	REPORT NO.	YEAR
Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase I: Theoretical Analysis	ETL-RN-74-9	1974
Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase II: Practical Considerations	ETL-RN-74-12	1975
Parallel Profile Plots for Visual Terrain Display	ETL-0115	1977
Particulate Matter Considerations in the Design of V/STOL Aircraft	ETL-SR-72-2	1972
Performance Evaluation of the Position and Azimuth Determining System (PADS) with an Improved Vertical Accelerometer	ETL-0166	1978
Phoenix Laser and Terrain Profile Test		1966
Photo Analysis of a Desert Area	ETL-0068	1976
Photo-Geomorphology of Coastal Landforms, Cat Island, Bahamas (Vol. II)	ETL-SR-74-5	1974
Photogrammetric and Tracking Network Analysis Program	ETL-CR-73-17	1973
Photogrammetric and Tracking Network Analysis Program for the UNIVAC 1108 Computer	ETL-0018	1975
Photogrammetric Applications to Field Artillery	56-TR	1970
Photogrammetric Aspects of the Heterodyne Optical Correlator	ETL-0095	1976
Photogrammetric Flash Triangulation for Corps of Engineers Field Use		
1st Interim Report		1960
2nd Interim Report	AD-265 036	1961
3rd Interim Report	AD-271 438	1961
Final Report	AD-271 439	1961
Photographic Visibility of Light Images on Aerial Film		1966
Photomap Reproduction System		1965
Pilot Program of Lunar Photography for Precise Selenodesy	AD-452 237	1964
Plastic-Scribing Color Separation for Military Cartography	1485-TR	1957
Platform Orientation System Test Program	ETL-0100	1976
Point Light Source Contact Printer	ETL-0084	1976
Photographic Technology Series		
Position and Azimuth Determining System (PADS)	ETL-ETR-74-i	1974
Position and Azimuth Determining System (PADS) Helicopter Study	ETL-0009	1975
Position and Surveying System (PASS)	ETL-CR-73-11	1973
Possibility of Adapting a Land Navigation System to Perform Artillery Survey	ETL-0078	1976
Post-Mission Smoothing and Analysis of the Measurements of the Change in the Deflection of the Vertical Obtained by the Rapid Geodetic Survey System (RGSS) at the White Sands Test Range	ETL-0065	1976

TITLE	REPORT NO.	YEAR
Potential of Thermal IR Imagery for Supplemental Map Information in Snow-Covered Areas	ETL-0059	1976
Potential Sand and Dust Source Areas	ETL-SR-72-1	1972
Practical Field Accuracy Limits for a Wild T-2 Theodolite	30-TR	1966
Practical Second-Order Theory for the Disturbance Potential and Deflections of the Vertical, Including an Analysis of the Limitations of the Molodensky/Brovar Series and Downward Continuation of Gravity	ETL-RN-71-1	1971
Practical Tests of the Theoretical Accuracy of Aerial Triangulation	RN-1	1962
Precise Photogrammetric Orientation and Data Determination of HIRAN Mapping System AN/APQ 73	AD-238 857	1960
Precision Enlarging Printer (4X)	27-TR	1966
Precision 2.0X Enlarging Printer	55-TR	1970
Precision 3.3X Enlarging Printer	ETL-ETR-71-3	1971
Precision STARAN Correlator	ETL-0133	1977
Predesign Data for the Radar Stereo Equipment Program	AD-701 169	1969
Preliminary Image Data Extraction Experiments with the Phase I, Automated Image Data Extraction System-I	ETL-RN-74-7	1974
Preliminary Radar Feature Extraction and Recognition Using Texture Measurement	ETL-0315	1983
Preliminary Reliability Prediction--MATS		1965
Preliminary Study into the Principles of Continuous Tone Electrophotography	AD-401 863	1962
Preproduction Model Cartographic EBR System	ETL-0246	1980
Proceedings of the International Symposium Figure of the Earth and Refraction	AD-825 792	1967
Product Improvement Test Report of Astronomic Surveying Equipment	28-TR	1966
Program and Test Procedures to Determine the Geocentric Coordinates and Orbital Parameters of an Unidentified Satellite	AD-617 698	1968
Program Maintenance Manual for the Reference Scene Software (RSS)	ETL-0067	1976
Programmer for Army Artillery Inertial Survey System (GEISHA)	AD-814 065	1963
Project SAND--Availability of Construction Materials in the Mekong Delta	Tech Memo 156-1	1968
Project SAND (Phase III)--Analysis of Remote Sensor Imagery of Selected Areas in the Mississippi Delta	ETL-TR-71-3	1971

TITLE	REPORT NO.	YEAR
Project THEMIS: A Center for Remote Sensing		
Study Plan	AD-690 361	1968
Progress Report	AD-847 276	1968
Interim Report	AD-683 584	1968
Progress Report	AD-853 884	1969
Progress Report	AD-864 859	1969
5th Semi-annual Report	AD-869 511	1970
6th Semi-annual Report	AD-879 981L	1970
7th Semi-annual Report (ETL-CR-71-7)	AD-726 966	1971
8th Semi-annual Report (ETL-CR-71-21)	AD-735 752	1971
Final Report (ETL-CR-74-10)	AD-A003 266	1974
Propagation of Very Short Radio Waves Through the Ionosphere and the Investigation of Ionospheric Models	ETL-RN-74-1	1973
Proposed Stereophotogrammetric System for Topographic Mapping from Photography Taken at Altitudes up to 100,000 Feet	1518-TR	1958
Prototype Automatic Mosaicking System	17-TR	1963
Prototype Electrostatic Image Reproducer	ETL-0035	1973
Prototype Image Spectrum Analyzer (PISA) for Cartographic Feature Extraction	ETL-0204	1979
Prototype Lithographic Enlarging Projection Platemaker	ETL-ETR-72-4	1972
Prototype Stereomat System	4-TR	1962
Quantitative Geography: Achievements and Prospects	ETL-CR-71-12	1971
RACOMS Cartographic Module	ETL-ETR-70-3	1970
RACOMS Compilation Module I	ETL-ETR-70-1	1970
RACOMS Data Processing Module	ETL-ETR-70-4	1970
RACOMS Image Processing Module I	47-TR	1969
RACOMS Image Processing Module II	ETL-ETR-70-2	1970
RACOMS Map Revision Module	ETL-ETR-70-5	1970
RACOMS Operations Module	44-TR	1969
RACOMS Pass Point Marking and Measuring Instrument	53-TR	1970
RACOMS Reproduction Module	ETL-ETR-71-1	1971
Radar Backscatter from a Vegetated Terrain: A Discrete Scattering Approach	ETL-0159	1979
Radar Bridge Patterns Extraction and Recognition	ETL-0323	1983
Radar Image Simulation of Seasonally Dependent Reference Scenes	ETL-0188	1979
Radar Image Simulation Project	ETL-0098	1976
Radar Image Simulation Project: Development of a General Simulation Model and an Interactive Simulation Model, and Sample Results	ETL-0047	1976
Radar Image Simulation: Validation of the Point Scattering Model, Volume I	ETL-0117	1977
Radar Image Simulation: Validation of the Point Scattering Model, Volume II	ETL-0118	1977

TITLE	REPORT NO.	YEAR
Radar Image Simulation: Validation of the Point Scattering Method Addendum	ETL-0155	1978
Radar Mapping Beacon Analysis	ETL-CR-73-22	1973
Radar Mapping Test Ranges		1959
Radar Network Adjustment		1962
Radar Presentation Restitutor		1956
Radar Sketching Device	20-TR	1965
Radar Stereo Equipment Program	AD-732 875	1971
Radar, Thermal Infrared, and Panchromatic Image Collection and Analysis	ETL-0249	1980
Radiative Transfer in One-Dimensional Discretely Stratified Media	ETL-0236	1980
RADOT Code for the Tracking of Radar Incident on Trees	ETL-0147	1978
RADOT Code System to Calculate the Radar Return from a Forested Area	ETL-0206	1979
Rainfall Intensities in the Conterminous United States and Hawaii (Supplement 1 to ETL-SR-72-5: Distribution of Mean Monthly Precipitation and Rainfall Intensities)	ETL-SR-74-3	1973
Rapid Cartographic Processing System Study	AD-454 086L	1964
Rapid Combat Mapping System Evaluation	ETL-ETR-70-8	1970
Rapid Geodetic Survey System	ETL-0074	1976
Rapid Geodetic Survey System (RGSS) Deflection of the Vertical and Gravity Anomaly Tests at White Sands Missile Range, 1980	ETL-0308	1982
Rapid Gravity Survey System Aided with Supplemental Gravimetric Data	ETL-0113	1977
RC-135A/USQ-28 Category II Test (The Photographic Resolution Capabilities of the KS-78A Camera Subsystem)	TM-69-1	1969
R&D Plan for Army Applications of AI/ROBOTICS	ETL-0296	1982
Recognition of Handprinted Symbols for Computer- Aided Mapping	ETL-CR-71-27	1971
Recording and Scanning Advances in Cartographic EBR Systems	ETL-0265	1981
Reduction and Classification of the Data Base List	AD-817 518	1967
Reduction Procedures for Absolute Direction and Geodetic Azimuths from Optical Observations of Satellites	RN-14	1965
Reflection and Identification Studies Applied to Terrain Imaging Radar	ETL-0331	1983
Refraction in Selected Model Atmospheres	AD-404 465	1964
Registration of a LANDSAT Image to a DTM-- An Error Analysis	ETL-0350	1984
Relation Between the Spectrum of Surface Slopes and the Spectrum of Surface Elevations and its Usefulness in the Theory of Electro- magnetic Wave Scattering from Rough Surfaces	ETL-RN-70-2	1970

TITLE	REPORT NO.	YEAR
Relational Data Base Management Study	ETL-0136	1978
Remote Sensor Image Capabilities for Acquisition of Terrain Information	ETL-0054	1976
Remote Sensor Imagery Analysis for Location of Construction Materials in the Mekong Delta--Project SAND (Phase II)	52-TR	1970
Replacement of Photographic Imagery Equipment (RPIE)	ETL-0038	1976
Report on Atmospheric Obstructions to Visibility: Volume I--Study Results	ETL-0169	1979
Report on Atmospheric Obstructions to Visibility: Volume II--Results of Literature Search	ETL-0170	1979
Research and Design of a PROM Coherent Optical Processor	ETL-0219	1980
Research and Development Acceptance Test Report Surveying Instrument: Azimuth, Gyro, Light-weight (Lear Siegler, Inc. Models)	23-TR	1965
Research and Development of a Prototype Laser Point Marking Instrument	AD-673 291	1967
Research in Space Photogrammetry		1961
Research in Surveying, Mapping and Geodesy	AD-230 066	1959-1965
Research Institute Lectures on Geography	ETL-SR-71-1	1971
Research on Refinement and Interpretation of Gravity Anomaly Computations		1968
Research Studies Related to Mapping, Geodesy, and Position Determination		1958-1961
Research Studies Related to Mapping, Geodesy, and Position Determination	AD-402 602	1963
Results of Space Triangulation Adjustments from Satellite Data	RN-13	1965
Review and Analysis of U.S. Army Geodetic SECOR System and Development	AD-818 483	1962
Review of New Geographic Methods and Techniques, Vol. I	AD-700 151	1969
Review of New Geographic Methods and Techniques, Vol. II	AD-700 176	1969
Review of Photosensitive Materials for Holographic Recordings	ETL-0128	1978
Road Boundary Detection for Autonomous Vehicle Navigation	ETL-0407	1985
Road Detection on Radar Imagery	ETL-0403	1985
Robotic Vehicle Terrain-Navigation Subsystem: Conceptual Design Phase	ETL-0332	1983
RPIE Symbol Placement Accuracy	ETL-0076	1976
Ruggedized Geodetic SECOR		1964
Ruggedized Geodetic SECOR System		1967
RWPF Spatial Data Study	ETL-0367	1984
Sand and Dust Considerations in the Design of Military Equipment	ETL-TR-72-7	1972

AD-A195 933

BIBLIOGRAPHY OF IN-HOUSE AND CONTRACT REPORTS
SUPPLEMENT 15(U) ARMY ENGINEER TOPOGRAPHIC LABS FORT
BELVOIR VA A BLACK ET AL. APR 88 ETL-8588

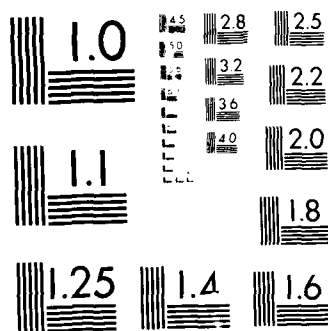
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TITLE	REPORT NO.	YEAR
Satellite Angulation	RN-16	1965
Satellite Geodesy Based on Stellar Orientation of Lines Between Unknown Stations	RN-32	1969
Satellite Observations of Widespread Fog	ETL-0361	1984
Satellite-to-Satellite Tracking for Orbit Improvement and Determination of a 1° x 1° Gravity Field	ETL-0064	1976
Satellite-to-Satellite Tracking Study for the Global Positioning System (Rotating-Y Configuration)	ETL-SR-74-6	1974
Satellite, U.S. Army Type II, Geodetic		1963
Scale Problems in Geographic Research	ETL-CR-71-16	1971
Scattering from a Vegetation Layer with an Irregular Vegetation Soil Boundary	ETL-0270	1981
Scattering of a Code-Modulated Radio Signal and Associated Multipath Range Errors	ETL-0125	1977
Scene Classification Results Using the Max-Min Texture Measure	ETL-0300	1982
Selected Bibliography of Corps of Engineers Remote Sensing Reports	ETL-0126	1977
Semiautomatic Coordinate Reader	ETL-ETR-71-4	1971
Semi-Automatic Pass Point Determination Using Digital Techniques	ETL-0051	1975
Sensing Array System with Image Statistics Processing, A	ETL-0297	1983
Sequential Independent Model Block Analytical Triangulation (SIMBAT)	AD-805 606L	1966
Service Tests and Subsequent Modifications and Test of Compass Sun, Universal, 0 to 90 Degrees North and South Latitudes, with Case	1422-TR	1955
Shaded Relief Images for Cartographic Applications	ETL-0259	1981
Side-Looking Radar Data Requirements for Automated Mapping on the UNAMACE	ETL-CR-72-18	1972
Side-Looking Radar Presentation Viewing and Measuring Instrument	22-TR	1965
Signal Signatures of Topographic Features Using Analog Technology	ETL-0185	1979
Simulation of a Radar Image for Garden City Test Site	ETL-0007	1975
Single-Lens, Four-Channel Multiband Camera (Report No. 3 in the ETL Series on Remote Sensing)	ETL-ETR-74-4	1974
Single Photo Analysis of Sampled Aerial Imagery	ETL-RN-74-10	1974
Software Conversion of Standard Linear Format (SLF) to Standard Interchange Format (SIF)	ETL-0394	1985
Solution of the General Analytical Aerotriangulation Problem	AD-202 318	1958

TITLE	REPORT NO.	YEAR
Some Relations Between the Geometrical Quality of Topographic Mapping and Aerial Photogrammetry	RN-7	1962
Spatial Light Modulators: Test and Evaluation	ETL-0192	1979
Spatial Sampling: A Technique for Acquisition of Geographic Data from Aerial Photographs and Maps	ETL-CR-71-11	1971
Spectral Reflectivity Data: A Practical Acquisition Procedure	AD-880 049L	1970
Spectral/Spatial Resolution Targets for Aerial Imagery (Report No. 1 in the ETL Series on Remote Sensing)	ETL-TR-74-3	1974
Stable Platform Assembly for Army Artillery Inertial Survey System	AD-681 932	1962
Stable Platform Electronics for Army Artillery Inertial Survey System (GEISHA)	AD-681 933	1962
Star Pattern Recognition and Spacecraft Attitude Determination	ETL-0173	1978
Star Pattern Recognition and Spacecraft Attitude Determination, Phase II	ETL-0211	1979
Star Pattern Recognition and Spacecraft Attitude Determination, Final Report	ETL-0260	1981
STARAN Image Processing	ETL-0243	1980
Stars' Position Determined by Combining Micrometric Observations with an Observed Known Star in a Vertical Plane Close to the Meridian	RN-20	1967
State-of-the-Art of Slope Mapping	ETL-0060	1976
Status of Aerial Color Photography in Government Agencies	TB-1	1968
Stereo Analysis of a Specific Digital Model Sampled from Aerial Imagery	ETL-0072	1976
Stereo Radar Analysis	AD-903 321L	1970
Stereo Radar Techniques Study, Phase I, Vol. I--Analysis	AD-800 171L	1966
Stereoplotter, Topographic, Projection-Type High Precision	1627-TR	1960
Stereoscopic Terrain Display for Measurement Applications	ETL-0002	1974
Stress Analysis, Study of the M4 Van Expandable and Adapter, Detachable Running Gear	AD-636 445	1966
Structural Analysis from Radar Imagery, Eastern Panamanian Isthmus	AD-715 322	1970
Studies in Zinc Oxide Photoconductivity	AD-673 836	1968
Studies of Gravity in Space According to Bjerhammer	AD-485 687L	1966
Study and Analysis of the Position and Azimuth Determining System (PADS) Field Maintenance Concept	ETL-CR-74-22	1974

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Study and Analysis of the Position and Azimuth Determining System (PADS) for Mapping, Charting, and Geodesy Applications	ETL-CR-73-12	1973
Study and Prototype Model Design of a Miniaturized Gyrocompass, Interim	AD-462 322	1964
Study and Prototype Model Design of a Miniaturized Gyrocompass, Final	AD-465 330	1965
Study of a Digital Interface Design for the Quick Response Multicolor Printer (QRMP)	ETL-0327	1983
Study of Classification and Nomenclature of Vegetation	ETL-0058	1976
Study of Digital Matching of Dissimilar Images	ETL-0248	1980
Study of Environmental Monitoring and Information Systems	ETL-CR-72-1	1972
Study of Knowledge-Based Systems for Photo Interpretation	ETL-0235	1980
Study of Lithographic Fountain Solutions	AD-830 674L	1967
Study of Panoramic-Metric Image Matching for Photogrammetric Instrumentation	AD-474 839L	1965
Study of Potential Application of Holographic Techniques to Mapping (Interim Report)	ETL-CR-70-8	1970
Study of Potential Application of Holographic Techniques to Mapping (Final Report)	ETL-CR-71-17	1971
Study of Raster Metafile Formats	ETL-0363	1984
Study of Solution of a Large System of Linearized Normal Equations and the Inversion of the Associated Coefficient Matrix	AD-676 849	1968
Study of Stereophotogrammetric Systems for Topographic Mapping with Very High Altitude Aerial Photography	1352-TR	1954
Study of the Accuracy of Visual Planimetric Pointings to Photographic Edges with Different Characteristics	ETL-CR-71-19	1971
Study of the Application of Piezoelectric Techniques to a Small North-Orienting Device	AD-486 467L	1966
Study of the Characteristics of the Holographic Stereomodel for Application in Mensuration and Mapping (Part I of Final Report)	ETL-CR-73-14	1973
Study of the Characteristics of the Holographic Stereomodel for Application in Mensuration and Mapping (Part II of Final Report)	ETL-CR-73-14	1973
Study of the Effect of Corona Conditions on Electrostatic Processes	ETL-CR-72-17	1972
Study of the Effects of Nonhomogeneous Target Backgrounds on Photogrammetric Coordinate Measurement		1969
Study of the Human Visual System in Support of Automated Feature Extraction	ETL-0271	1981
Study of the Impact of the Global Positioning System on Army Survey	ETL-0070	1976

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Study of the Interaction of a Positive Corona with Selenium Coatings Relevant to the IFAX Printing Process	ETL-CR-74-7	1974
Study of the Long Range Position Determination System	AD-505 912	1969
Study of Visual Stereoscopic Acuity		1956-1957
Study to Establish a Method of Selecting Input Photographic Material for Automated Compilation Equipment	ETL-CR-71-24	1971
Study to Optimize Performance of the Rapid Geodetic Survey System--Interim Technical Report	ETL-0252	1981
Study to Optimize Performance of the Rapid Geodetic Survey System--Second Interim Technical Report, A	ETL-0264	1981
Study to Optimize Performance of the Rapid Geodetic Survey System--Addendum Report, A	ETL-0321	1983
Surface Climate of the Arctic Basin	ETL-TR-71-5	1971
Surface Gravity Effects of Subterranean Tunnels	ETL-0069	1976
Surface Materials and Terrain Features of Yuma Proving Ground, Part I Summary Description	ETL-0021	1975
Survey of Digital Image Display Systems (Soft Copy)	ETL-0085	1976
Survey of Digital Image Scanning Systems	ETL-0087	1976
Survey of Display Devices (Hard Copy)	ETL-0086	1976
Survey of Mass Storage Systems	ETL-0082	1975
Surveying Instrument: Azimuth, Gyro, Lightweight (SIAGL) (Lear Siegler, Inc.)	ETL-TR-72-2	1972
Synthesis Guide for Cross-Country Movement (Report No. 4 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0220	1980
Synthesis Guide for Lines of Communication (Report No. 7 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0263	1981
Synthesis Guide for Obstacle Siting (Report No. 9 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0283	1982
Synthesis Guide for River Crossings (Report No. 11 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0344	1983
System Analysis of the Entire Topographic Support System	ETL-0390	1985
System Analysis of the Entire Topographic Support System (TSS), Final Report	ETL-0158-2	1978
System Analysis of the Entire Topographic Support System (TSS), Interim Report	ETL-0158-1	1978
System and Design Study for an Advanced Drum Plotter	ETL-CR-70-3	1970

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System for Automatic Secure Transmission and Reception of Topographic Information--Maps, Photographs, or Alphanumeric Facsimile--at TV Rates	ETL-CR-71-2	1971
System for Topographic Inquiry--No. 1 Micrographic Subsystem	ETL-ETR-74-2	1974
System for Topographic Inquiry--No. 2, Alphanumeric Subsystem	ETL-0003	1975
System for Topographic Inquiry--No. 3, Alphanumeric Subsystem Data Base Listing	ETL-0004	1975
System for Topographic Inquiry--No. 4, Program Conversion Procedures	ETL-0005	1975
System for Topographic Inquiry--No. 5, Alphanumeric Subsystem Users Guide	ETL-0031	1975
Systematic Correction and Weighting of Analogue Aerial Triangulation Observations and Their Use in Strip and Block Adjustments	AD-476 273L	1965
Systematic Investigations of Geodetic Networks in Space, Interim	AD-482 852L	1966
Systematic Investigations of Geodetic Networks in Space, Final	AD-815 717	1967
Systems Concepts for Military Geographic Intelligence, Vol. I		1967
Tactical/Strategic Point Positioning Study	ETL-0319	1981
Technical Data on KC-Film, Toners, and Processes	ETL-0224	1980
Technical Report for Automatic Line Follower	ETL-CR-72-18	1972
Television Display of Topographic Information	ETL-CR-70-7	1970
Television Display of Topographic Information, Phase II	ETL-CR-71-23	1971
Terrain Analysis Procedural Guide for Built-Up Areas (Report No. 13 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0352	1984
Terrain Analysis Procedural Guide for Climate (Report No. 5 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0247	1980
Terrain Analysis Procedural Guide for Drainage and Water Resources (Report No. 8 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0285	1982
Terrain Analysis Procedural Guide for Geology (Report No. 3 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0207	1979
Terrain Analysis Procedural Guide for Railroads (Report No. 10 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0311	1982
Terrain Analysis Procedural Guide for Roads and Related Structures (Report No. 2 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0205	1979

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Terrain Analysis Procedural Guide for Soil (Report No. 6 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0254	1981
Terrain Analysis Procedural Guide for Surface Configuration (Report No. 12 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0352	1984
Terrain Analysis Procedural Guide for Vegetation (Report No. 1 in the ETL Series on Guides for Army Terrain Analysts)	ETL-0178	1979
Terrain Analyst Synthesizer Station	ETL-0231	1980
Terrain Data of Mount Hayes D-4 Quadrangle, Fort Greely, Alaska (Report No. 4 in the ETL Series on Remote Sensing)	ETL-TR-74-7	1974
Terrain Effects Analysis Routine for an MGI System	ETL-0010	1975
Terrain Eigenvector Dyad Analysis	AD-649 347	1967
Terrain Factor Analysis and Automatic Color Coded Mapping Utilizing the IDECS	ETL-CR-72-13	1972
Test and Evaluation of a Baudot-FIELDDATA Code Converter, Paper Tape	15-TR	1963
Test and Evaluation of 9 by 18 Rectifier for 12- and 24-inch Focal Length Photography	1460-TR	1956
Test and Evaluation of Target Map Coordinate Locator Equipment	14-TR	1963
Test and Evaluation of the Analytical Photogrammetric Positioning System, Advanced (APPS-II)	ETL-0293	1982
Test and Evaluation of the Direct Viewing Stereoplotter, Wernstedt-Mahan Type	1471-TR	1957
Test and Evaluation of the Headliner, Model 400	1568-TR	1959
Test and Evaluation of the Interim Halcon Mapping System	3-TR	1961
Test and Evaluation of the Interim Stereo- plotter, Topographic, Projection Type, High Precision	1493-TR	1957
Test and Evaluation of the Kelsh Plotter, Model 5000, Manufactured by the Instruments Corp.	1311-TR	1953
Test and Evaluation of the Near Real Time Exploitation System	ETL-0281	1982
Test and Evaluation of the Prototype Side-Looking Radar Restitutor	29-TR	1966
Test and Evaluation of the Santoni Cartographic Stereomicrometer	1644-TR	1960
Test and Evaluation of the 720 Plotter Manufactured by Bausch and Lomb Optical Co.	1348-TR	1954
Test and Evaluation of the Stereopontometer and Adapted Multiplex	1381-TR	1954
Test and Evaluation of the Stereopontometer with Kelsh Type Stereoplotters	1425-TR	1955

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Test and Evaluation of Ultrasonic Scribing Equipment	1641-TR	1960
Test and Investigation of the Photonymograph (PN-4)	1537-TR	1958
Test of Map-Read Magnetic Declination Accuracy	ETL-148	1978
Test of Reconnaissance Photographic Transposer AN/GSH-1()	1566-TR	1959
Test Results of a Singer, Kearfott Division Modified Land Navigation System	ETL-0238	1980
Test Results of the Lear Siegler, Singer and Sperry Gyro Heading Reference Systems	ETL-0288	1982
Test Results of the Litton Low-Cost Semi-Strapped-Down Inertial Land Navigation System	ETL-0202	1979
Test Strategy for High Resolution Image Scanners, A	ETL-0345	1983
Testing and Evaluation of the Shiran System by Advanced Data Reduction Methods		1969
Testing of an Experimental Viscous-Friction Coupled Small North Orienting Device	AD-822 011	1967
Tests and Evaluation of an Automatic Point Reading, Plotting, and Grid Ruling Machine	8-TR	1962
Tests and Evaluation of an Earth Curvature Correction Device	10-TR	1963
Tests and Evaluation of the AS-11A Stereoplotter	50-TR	1969
Tests and Evaluation of the Zeiss Stereotype Stereoplotting Instrument	1567-TR	1959
Tests and Evaluation of Ultrawide-Angle Mapping Photography	6-TR	1961
Tests and Evaluations of Precision Coordinatographs	1-TR	1961
Tests of Basic Geometrical Qualities of Photogrammetric Plotting Instrument	RN-5	1962
Tests on the Change Detector		1964
Texture Analysis and Cartographic Feature Extraction	ETL-0370	1985
Texture Tone Study--Category Maps, Gradient and Homogeneity Images	ETL-CR-73-10	1973
Texture Tone Study--Classification Experiments	ETL-CR-72-16	1972
Texture Tone Study (Quantizing on the IDECS/PDP)	ETL-CR-72-3	1972
Texture Tone Study: Summary and Evaluation	ETL-0005	1975
Texture Tone Study with Application to Digitized Imagery	TR-182-1	1970
Texture Tone Study with Application to Digitized Imagery (Interim Report)	ETL-CR-71-14	1971
Texture Tone Study with Application to Digitized Imagery (Final Report)	ETL-CR-74-17	1974
Theodolite with Shaft Angle Encoder and Display	AD-662 080	1967
Theoretical and Experimental Study of Wave Scattering from Composite Rough Surfaces	ETL-CR-74-4	1974

TITLE	REPORT NO.	YEAR
Third-Order Co-Occurrence Texture Analysis Applied to Samples of High Resolution Synthetic Aperture Radar Imagery	ETL-0396	1985
Topographic Data Output Study	AD-262 161L	1961
Topographic Eigenvector Analysis	AD-484 747L	1966
Topographic Radar Mapping Systems Design Study		1968
Topographic Relaxation Study	ETL-0209	1979
Total Optical Color System (Report No. 2 in the ETL series on Remote Sensing)	ETL-ETR-74-3	1974
Toward Automatic Extraction of Cartographic Features	ETL-0153	1978
TPLOT: A Simple Program for Plotting Percent Composition Data on Ternary Diagrams	ETL-RN-74-2	1973
Training Course on Data Reduction of Radar Topographic Imagery		1969
Transformation of Coordinates of Cartographic Digital Data	ETL-TR-74-8	1974
Transformations for Dimension Reduction and Expansion of the Discrete Fourier Transform Under Scanning	ETL-RN-74-3	1974
Transforming Printers: Acceptance and Engineering Tests	40-TR	1968
Transitional Design Study of the Position and Azimuth Determining System (PADS)	ETL-0001	1975
Tribrach, Universal	1453-TR	1956
Tripod, Universal, Final Report on Project 8-35-10-107	1413-TR	1955
Two Approaches to a Portable Color-Measuring System	RN-15	1966
Two-Way Linear Interpolation	ETL-RN-71-5	1971
Type I Geodetic Satellite		1964
Typro Composer Photolettering Machine	1504-TR	1957
Unified Approach to Mapping, Charting, and Geodesy (MC&G) Data Base Structure Design	ETL-0144	1978
Unified Geodetic Parameter Program (GEOPS), Vol. 1 of 2--Mathematical Analysis	AD-640 321	1966
Unified Geodetic Parameter Program (GEOPS), Vol. 2 of 2--Program Description	AD-640 322	1966
Universal Analog Rectification System for Map Revision	24-TR	1965
Universal Automatic Map Compilation Equipment	51-TR	1969
Universal Radar Signal Processor (Correlator), Interim	AD-487 144L	1966
Universal Radar Signal Processor (Correlator), Final	AD-841 545L	1968
U.S. Army Type II Geodetic Satellites		1965
Use and Calibration of Distance Measuring Equipment for Precise Mensuration of Dams	ETL-0048	1976

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Use and Calibration of Distance Measuring Equipment for Precise Mensuration of Dams (Revised)	ETL-0190	1979
Use of a Vidicon to Digitize Certain Types of Target Image in a Photographic Background	AD-457 818L	1964
Use of Array Algebra in Terrain Modeling Procedures	ETL-0094	1976
Use of Edges of Photographic Images as Specifiers of Image Quality	ETL-CR-72-15	1972
Use of Radar Images in Terrain Analysis: An Annotated Bibliography	ETL-0024	1975
Use of Side-Looking Airborne Radar (SLAR) Imagery for Engineering Soils Studies	46-TR	1969
User's Guide to Data Preparation, Photogrammetric Navigation Analysis Program Fotonap	ETL-0174	1978
User's Manual for the Reference Scene Software (RSS)	ETL-0066	1976
Using Terrain Analysis to Predict Likely Minefield Sites	ETL-0325	1983
Utility of Radar Imagery in the Production of Tactical Terrain Data. Military Capabilities Report	ETL-0045	1975
Utilization of a Photogrammetric Facility (PF) in Human Engineering Laboratories Battalion Artillery Test Number Two (HELBAT II)	ETL-SR-71-2	1971
Variscale Stereo Point Marking Instrument	39-TR	1968
Vegetation and Terrain Effects on Digital Classification of LANDSAT Imagery	ETL-0292	1982
Vegetation and Terrain Relationships in South-Central New Mexico and Western Texas	ETL-0245	1980
Vegetation Data Extraction Software Documentation/User's Manual	ETL-0340	1983
Vegetative Cover Effects on Soil Spectral Reflectance	ETL-0284	1982
Vertical Obstruction Study, Final Report	ETL-0358	1984
Video Stream Processors: A Cost-Effective Computational Architecture for Image Processing	ETL-0229	1980
Visual Factors Affecting the Precision of Coordinate Measurement in Aerotriangulation	RN-21	1967
Visual Navigation System for Autonomous Land Vehicles, A	ETL-0408	1985

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Voice Interactive Systems Technology (VIST) Research	ETL-0349	1984
Voice Interactive Systems Technology (VIST) Research	ETL-0349	1984
Weather Extremes Around the World (Revision of NLABS Report TR-70-45-ES)	ETL-TR-74-5	1974
Weighted Line-Finding Algorithm	ETL-0200	1979
Wind Design Criteria for Field Shelters--A Study	ETL-0037	1975
Wire List GEISHA Computer	AD-847 667	1969
World Areas More Humid Than the Canal Zone during the Wet Season (Note 3 of "Studies to Aid TECOM in Analyses of Environmental Risks to Materiel")	ETL-RN-74-8	1974
World Areas with Higher Precipitation Intensities and Frequencies than the Tropic Test Center, Canal Zone	ETL-0022	1975
World Areas with Higher Temperatures than the Yuma Proving Ground During Summer (Note 2 of "Studies to Aid TECOM in Analyses of Environmental Risks to Materiel")	ETL-RN-74-6	1974
World Areas with Lower Temperatures than the Arctic Test Center During Winter (Note 1 of "Studies to Aid TECOM in Analyses of Environmental Risks to Materiel")	ETL-RN-74-5	1974
Worldwide Distributions of Ambient Temperatures and Temperatures of Materiel Exposed to Direct Solar Radiation	ETL-SR-73-2	1972
Worldwide Distribution of Mean Dewpoint: Surface and Lower Atmosphere	ETL-SR-72-4	1972
Worldwide Distribution of Mean Monthly Dewpoint (Supplement to ETL-SR-72-4 "Worldwide Distributions of Mean Dewpoint: Surface and Lower Atmosphere")	ETL-SR-72-2	1973
Xerox 6500 Color Copier	ETL-0106	1977
Zoom Transfer Scope	ETL-ETR-72-5	1972

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